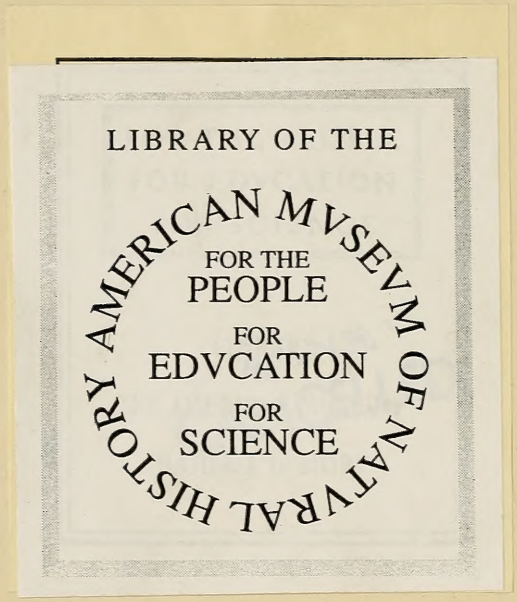
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ANNUAL REPORT

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OF THE

MAINE STATE COLLEGE

AGRICULTURAL EXPERIMENT STATION

1891.

BANGOR:
CHAS. H. GLASS & CO., PRINTERS,
1892.



MAINE EXPERIMENT STATION CHEMICAL LABORATORY AND OFFICES.

MAINE STATE COLLEGE,

AGRICULTURAL EXPERIMENT STATION.

in Pub'd May 18

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TREASURER'S REPORT.

THE MAINE AGRICULTURAL EXPERIMENT STATION,
In account with
THE UNITED STATES APPROPRIATION.

RECEIPTS.

From the Treasurer of the United States, as per appropriation for the year ending June 30, 1891	$14,999 87

EXPENDITURES.

Construction and repairs	$77 57
Fuel	170 38
Field and feeding	1,625 75
General expense	149 29
Salaries	9,051 49
Horticultural Department	453 14
Library	93 33
Printing	1,831 39
Stationery and Postage	97 03
Travelling expenses	182 76
Veterinary Science	49 71
Water supply	1,300 00
Chemical Laboratory	440 39
Botany and Entomology	26 95
Fertilizer inspection	190 34
Meteorology	24 35
Trustee expenses	48 50
	$15,812 37

DIRECTORS' REPORT.

M. C. Fernald, Ph.D., President Maine State College:

SIR:—The report of the Maine Experiment Station for 1891, which is herewith submitted, contains, it is believed, evidence that the work of the Station is increasing, not only in amount, but importance. During no year of the Station's existence has so large a percentage of its funds been applied directly to actual experimental work, as in the year which now ends. Previously it has been necessary to use quite a percentage of the funds in procuring the required equipments for the various departments, but now that the needed appliances are fairly well supplied, it is reasonable to expect more extensive and more varied experimentation than has heretofore been possible.

LIMITATIONS OF THE STATION RESOURCES.

It is probable that only those who are directly concerned in the management of the Station realize the extent of the demands made upon it for work along the various agricultural lines. We have in the State of Maine stockmen, dairymen and fruit growers, and to each of these classes of producers are presented many problems of great economic importance. More and more are agriculturists looking to the work of the experiment station as a means of solving these problems and the dairyman is not less backward than the fruit grower in asking that he receive his fair share of attention.

In view of the requirements that are laid upon the Station, $15,000 is not a large sum of money, although to some it may seem to be.

It should be remembered, however, by those who have a feeling of disappointment in what is being accomplished, if there are such, that each line of work requires a specialist with special apparatus. It should also be remembered that the scientific problems pertaining to agriculture can not be solved at a uniform rate of so many per day or year as we would manufacture boots or chairs or any other commodity. If through accident, unforeseen circumstances or an error of judgment in the regulation of conditions, an investigation becomes a failure in the season of 1891, it must wait for a repetition until 1892, with no guarantee

of success then. There is nothing mechanical about the work of the investigator. He must wait for the place and the hour when he can with certainty declare a new truth or point out a new application of an old truth.

The Fertilizer Control.

As has already been pointed out, the inspection of fertilizers is at the present time made possible through the use of money appropriated by the United States Government. In no other state is this the case. It is certainly unfortunate that in Maine we are following a policy which appears to be condemned every where else, for in all other states where a fertilizer control system exists, it is supported by funds obtained either from licenses on the sale of fertilizers, or from direct appropriations by the state. At a meeting of the Association of Land Grant Colleges and Experiment Stations held at Champaign, Ill., the peculiar relation which the Maine Experiment Station sustains in this particular was sharply pointed out. It is certainly very undesirable that our Station should attain notoriety of this kind. In view of the fact that the course pursued at this Station is in this respect not in accord with usage elsewhere, and because there is so pressing a demand for the use of more funds in the actual work of experiment and investigation, I feel compelled to recommend that some means be devised for carrying on the fertilizer inspection without drawing upon the Government Appropriation.

It may be proper to notice briefly in this connection a complaint which is made yearly, and which may now be regarded as chronic, in regard to the publication of the Station analyses of fertilizers. It is claimed by those who find fault, that the results of the inspection should be made known before the time when farmers find it necessary to purchase fertilizers in the spring. To say that this can not be done is a statement of fact, and though the briefest, it may not be a convincing argument with which to meet the complaint. If, however, the farmers of the state could understand the matter as fully as do the officers of the Station, no argument would be required to assure them of the impossibility of going into the markets and collecting two hundred or more samples of fertilizers, representing seventy-five brands, analyzing these samples, making up the report and publishing it before the month of May opens. The fact that the older fertilizer control stations, such as those in Connecticut, Massachusetts and New

Jersey, do not publish the results of their inspection until as late as July, August and September, or at least did not in the year 1891, should convince any who may be dissatisfied that the Maine Station is not derelict in duty. It certainly would be of advantage if the results of the inspection could be known earlier, and there would be general approval of any change in the existing law which would render this possible. None should feel, however, that under present conditions nothing of value is accomplished. If an inferior fertilizer is sold in the state, the Station inspection is sure to discover it, as has been done in several instances, and the publication of the analyses, even several months later than seems desirable, will certainly effectively discourage the further sale of unsatisfactory goods.

Increased Facilities.

Each year since the Station was organized has seen some enlargement of equipment, either of men or apparatus, and the year 1891 has proved to be no exception in this respect. The most notable gain has been in the organization of horticultural work. This was made possible through the election early in the year, of W. M. Munson, B. S., a graduate of the Michigan Agricultural College, and for two years first assistant of Prof. Bailey in the Cornell University Experiment Station. Prof. Munson comes to the Station with a thorough training, both in the scientific relations and in the art of horticulture, and the development which his department has already attained gives excellent promise of future success. During the year a new Head-house has been built in connection with the Forcing-house, partly at the expense of the Station, the interior of the Forcing-house has been improved for experimental purposes, the experimental value of the Station gardens has been greatly increased by the addition of new varieties and by an improvement in arrangement, and the outside work in farmers' orchards in studying varieties and in testing the efficacy of certain fungicides and insecticides has been enlarged. There has also become available through the erection of the new Dairy-house, increased opportunities for the testing of methods in the manipulation of milk, and to some extent this work has been entered upon. In the basement of the new barn, pens especially adapted to experimental swine feeding have been built. On the whole, the past year has been one of substantial progress and it is hoped that

what has been done may stand as evidence that the funds of the Station are being carefully applied to the work that is demanded.

A mistake which the management of an experiment station may easily make is to undertake too much, that is, enter upon too many lines of experiment and investigation. A correct conclusion in regard to a principle or fact relating to the practice of Agriculture may be of incalculable value, while an incorrect statement may do great harm. Nothing should be undertaken which can not be thoroughly done, and all experiments and investigation should be sufficiently exhaustive to make possible sound conclusions. For these reasons, there is no doubt but the Maine Experiment Station has multiplied its lines of work up to the limit that is consistent with a wise policy. It is not impossible that in the future restriction, rather than enlargement, may be found necessary.

ACKNOWLEDGMENTS.

I desire to express my lively appreciation, which I am sure is in harmony with the sentiments of my associates, of the generous and valuable assistance which the Station receives from the representatives in the Station Council of the Agricultural organizations of the State. It is also a pleasure to state that the members of the Station force have labored together during the past year with the utmost harmony: and that those associated with me have taken up the duties assigned them with faithfulness and efficiency.

The Station is under great obligations to J. M. Sears, Esq., of Boston, Mass., for the gift of a fine pair of Tamworth pigs. These animals are now being used for experimental purposes, with results that are already interesting.

Gifts of shrubs, vegetable and flower seeds, etc., have been received as follows:

J. M. Thorburn & Co., New York, N. Y., vegetable seeds.

John Lewis Childs, Floral Park, N. Y., Ipomea Learii, Ipomea Noctophyton, Ipomea Mexicana, seeds of vegetables and flowers.

O. M. Lord, Minnesota City, Minn., Cions Native Plums.

E. W. Burbank, Fryeburg, Me., miscellaneous collection vegetable seeds.

Francis Brill, Hempstead, N. Y., miscellaneous collection vegetable seeds.

H. A. Marsh, Fidalgo, Wash., miscellaneous collection vegetable seeds.

S. L. Goodale, Saco, Me., 10 varieties ornamental trees and shrubs.

The following newspapers and other publications are kindly donated to the Station by the publishers:

Dairy World, Chicago, Ill.
Farmers' Home, Dayton, Ohio.
Holstein Friesian Register, Boston, Mass.
American Creamery, Chicago, Ill.
Farm and Home, Springfield, Ill.
Good Will Record, East Fairfield, Me.
New Dairy, New York, N. Y.
Jersey Bulletin, Indianapolis, Ind.
Monthly Bulletin, Philadelphia, Pa.
Orange Judd Farmer, Chicago, Ill.
Farmers' Advocate, London, Ont.
Maine Farmer, Augusta, Me.
Southern Cultivator, Atlanta, Ga.
American Dairyman, New York, N. Y.
American Analyst, New York, N. Y.
American Rural Home, Rochester, N. Y.
Western Garden, Des Moines, Iowa.
Western Resources, Lincoln, Neb.
Columbus Record, Columbus, Ohio.
Metropolitan Rural Home, New York, N. Y.
The Pharmaceutical Era, Detroit, Mich.
The Sun, Baltimore, Md.
National Provisioner, New York, N. Y.
Massachusetts Ploughman, Boston, Mass.
Practical Farmer, Philadelphia, Pa.
Home and Farm, Louisville, Ky.
New England Farmer, Boston, Mass.
Progressive Thinker, Chicago, Ill.
Louisville Planter, New Orleans, La.
American Homestead, Omaha, Neb.
Mirror and Farmer, Manchester, N. H.
Texas Farmer, Dallas, Texas.
The Husbandman, Binghamton, N. Y.
Hoard's Dairyman, Ft. Atkinson, Wis.
Iowa Farmer and Breeder, Cedar Rapids, Iowa.
Detroit Free Press, Detroit, Mich.
Orange County Farmer, Port Jervis, N. Y.

Farm Journal, Philadelphia, Pa.
Delaware Farm and Home, Wilmington, Del.
The Western Rural, Chicago, Ill.
American Cultivator, Boston, Mass.
Farmer's Review, Chicago, Ill.

W. H. JORDAN,
Director.

MAINE STATE COLLEGE,
ORONO, ME., Dec. 31, 1891.

MAINE AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 1.

SECOND SERIES.

PARTIAL STATEMENT OF ANALYSIS OF COMMERCIAL FERTILIZERS FOR 1889.

The fertilizer law in force in Maine requires the annual analysis of three samples of each brand of fertilizer sold in the State. It is simply impossible to secure and analyze so many samples and publish the results before farmers purchase their fertilizers in the spring. Consequently this partial statement is made of analyses performed to date.

The following are the trade values in use this year, as determined from data collected in Connecticut, Massachusetts, and other States. For explanation of terms, etc., see *Station Bulletin* No. 23, issued in 1888.

THE TRADE-VALUES FOR 1889 OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS.

The average Trade-Values or *retail cost per pound* of the ordinarily occurring forms of nitrogen, phosphoric acid and potash are as follows:

	Cts. per lb.
Nitrogen in ammonia salts	19
nitrates	17
Organic nitrogen in dry and fine ground fish, meat and blood	19
cotton seed meal and castor-pomace	15
fine bone and tankage	16½
fine medium bone and tankage	13
medium bone and tankage	10½
coarser bone and tankage	8½
hair, horn shavings and coarse fish scrap	8
Phosphoric acid, soluble in water	8
ammonium cirate	7½
dry ground fish, fine bone and tankage	7
fine-medium bone and tankage	6
medium bone and tankage	5
coarser bone and tankage	4
fine ground rock phosphate	2
Potash as high-grade Sulphate and in forms free from Muriate (or Chlorides)	6
as kainit	4½
as muriate	4½

W. H. JORDAN, Director.

ORONO, ME., May 1, 1889.

Station Number.	Brand.	Manufacturer.	Sample Selected at
437	Allen Fertilizer	American Manufacturing Co., Boston, Mass	Saco.
447	Americus Ammoniated Bone Superphosphate	Williams & Clark Co., New York, N. Y	Bowdoinham.
404	Crocker's Ammoniated Bone Superphosphate	Crocker Fertilizer & Chemical Co., Buffalo, N. Y	Orono.
412	Bay State Fertilizer	Clark's Cove Guano Co., New Bedford, Mass	Pittsfield.
425	Bay State Superphosphate	J. A. Tucker & Co., Boston, Mass	So. Paris.
430	Bowker's Hill and Drill Phosphate	Bowker Fertilizer Co., Boston, Mass	Oxford.
414	Bradley's Potato Manure	Bradley Fertilizer Co., Boston, Mass	Bangor.
410	" Eureka Seeding Down Fertilizer	" " " " "	Fairfield.
451	Cleveland Potato Phosphate	Cleveland Dryer Co., Boston, Mass	Gardiner.
450	" Superphosphate	" " " " "	"
417	Cumberland Bone Superphosphate	Cumberland Bone Co., Portland, Me	Bangor.
416	" Seeding Down Fertilizer	" " " " "	"
443	Dirigo Fertilizer	Sagadahoc Fertilizer Co., Bowdoinham, Me	Bowdoinham.
442	E. F. Coe's Alkaline Bone	E. Frank Coe's, New York, N. Y	Saco.
441	E. F. Coe's High Grade Ammoniated Bone Superphosphate	" " " " "	"
411	Gloucester Fish and Potash	Bowker Fertilizer Co., Boston, Mass	Fairfield.
403	Potato, Hop and Tobacco Phosphate	Crocker Fertilizer & Chemical Co., Buffalo, N. Y	Orono.
446	Potato Phosphate	Williams & Clark Co., New York, N. Y	Bowdoinham.
433	Quinnipiac Potato Manure	Quinnipiac Co., New London, Ct	Auburn.
432	Quinnipiac Phosphate	" " " " "	"
444	Sagadahoc Superphosphate	Sagadahoc Fertilizer Co., Bowdoinham, Me	Bowdoinham.
449	Soluble Pacific Guano	Soluble Pacific Guano Co., Boston, Mass	Gardiner.
408	Stockbridge's Corn and Grain Manure	Bowker Fertilizer Co., Boston, Mass	Waterville.
407	" Grass Top Dressing	" " " " "	"
405	" Potato and Vegetable Manure	" " " " "	"
406	" Seeding Down Fertilizer	" " " " "	"
419	Unicorn Ammoniated Superphosphate	Clark's Cove Guano Co., New Bedford, Mass	Bangor.

NOTE.—This Bulletin has been delayed several days in order to verify analyses, the accuracy of which was doubted by the manufacturers.

Station Number.	Brand.	Moisture.	Nitrogen.	Phosphoric Acid.			Potash.	Station Valuation
				Soluble.	Reverted.	Insoluble.		
437	Allen's Fertilizer	20.47	2.17	4.64	1.72	2.29	5.00	$ 24.12
447	Americus Ammoniated Bone Superphosphate	10.31	2.61	8.74	1.83	0.42	3.12	30.49
404	Crocker's " " "	12.86	2.84	7.74	1.87	1.68	1.47	28.29
412	Bay State Fertilizer	10.70	2.91	6.58	4.17	1.92	2.34	30.97
425	Bay State Superphosphate	15.20	2.72	6.49	2.42	1.04	2.24	26.98
430	Bowker's Hill and Drill Phosphate	10.14	3.31	6.72	2.48	3.39	1.14	29.93
414	Bradley's Potato Manure	10.68	2.96	5.56	2.16	1 96	5.69	29.48
410	" Eureka Seeding Down Fertilizer	9.63	1.91	4.32	3.15	4.51	2.57	23.91
451	Cleveland Potato Phosphate	11.48	2.33	5.99	2.52	4.21	3.64	27.68
450	" Superphosphate	14.22	4.08	8.00	2.02	1.52	2.55	34.53
417	Cumberland Bone Superphosphate*	11.24	2.19	6.36	6.17	2.80	2.18	31.24
416	" Seeding Down Fertilizer	10.15	2.00	2.19	3.87	14.78	0.30	25.91
443	Dirigo Fertilizer	9.41	3.15		4.31	7.91	2.52	25.40
442	E. F. Coe's Alkaline Bone	10.14	0.98	8.25	2.22	2.80	1.90	23.97
441	" " High Grade Ammoniated Bone Superphosphate	9.28	2.34	8.79	1.46	1.56	2.19	28.55
411	Gloucester Fish and Potash	10.92	1.77	6.72	2.41	5.90	2.03	26.46
403	Potato, Hop and Tobacco Phosphate	13.79	1.75	8 96	1.72	1.01	3 93	27.71
446	Potato Phosphate	12.18	2.84	6.41	1.38	0.47	6.28	30.66
433	Quinnipiac Potato Manure	21.50	2.86	3.62	3 08	1.46	4.78	26.46
432	" Phosphate	18.92	2.66	4.25	6.30	2.50	1.40	30.39
444	Sagadahoc Superphosphate	15.63	2.82	6.08	2.71	2.02	2.42	27.83
440	Soluble Pacific Guano	12.80	2.91	6.23	1.92	2.70	2.40	27.74
408	Stockridge Corn and Grain Manure	9.08	3.26	5 95	3.05	3.19	4.28	31.85
407	" Grass Top Dressing	7.17	4.85	2.87	2.44	5.13	0.21	34.08
405	" Potato and Vegetable Manure	8.78	3.50	6.04	2.48	3.03	0.48	34.16
406	" Seeding Down Fertilizer	8.23	3.06	5.59	1.50	5.97	4.04	29.82
419	Unicorn Ammoniated Superphosphate	12.77	2.11	3.77	4.80	3.88	2.00	25.01

* A sample of goods manufactured last year, and shipped to Bangor last fall.

MAINE AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 2.

SECOND SERIES.

THE APPLE MAGGOT.

Trypeta pomonella, Walsh.

PROF. F. L. HARVEY.

(Prof. Harvey has, by nearly two years patient labor, the results of which will appear in a more elaborate and detailed form later, completely worked out the life history of the apple maggot, which is doing such immense injury to fruit in some parts of our State. The practical points of his researches are herewith presented. In securing these results the Station has done its part of the work. The fruit growers must do the rest. If the recommendations which Prof. Harvey makes could be faithfully and universally followed for two years, there would be few traces of the apple maggot left in the State. Concerted and vigorous action on the part of fruit growers is needed.

W. H. JORDAN, Director.)

Last season quite extended and careful observations were made to determine the habits of this troublesome insect and many interesting and novel facts gathered pertaining to its life changes. This summer the studies have been continued and the observations of last season so supplemented and verified that we are now able to announce all the steps in its complete life history. The details of work by which these results were obtained will be fully considered and illustrated in a subsequent bulletin. The object now is to give tersely the steps in the life history of the insect, call

attention to the weak and strong points in its life changes, indicate useless methods of coping with it and suggest such preventive and direct remedial measures as are likely to check its ravages.

LIFE HISTORY.

The *perfect insect* is a two-winged fly somewhat smaller than the house fly.

It was briefly described in the Annual Report of the Experiment Station, 1888, page 175. The figure there given of the female shows the general nature of the fly, though incorrect in some details.

The flies appear in this State early in July and continue to emerge from the ground for about six weeks or two months. They soon begin to deposit eggs in the early apples, which are at that time from one-half to two-thirds grown. The later flies affect the later varieties.

Each female is capable of depositing over 300 eggs, which are inserted from time to time, one in a place, by means of a sharp ovipositor, through the skin of the apple. The maggots hatch in a few days and become full grown in four to six weeks when they are one-fourth inch long. They tunnel or "railroad" the pulp of the apple rendering it worthless.

The larvæ remain in the apples until they are ripe and occur as abundantly in the windfalls as in the hanging fruit. Larvæ of several ages may be found in the same fruit. Soon after they are mature the larvæ leave the apples through characteristic irregular openings in the skin, and if conditions are favorable, go into the ground an inch or less, or on sod ground, they remain about the grass roots. In a short time they change to the pupa state and remain in that condition until the next season when the flies emerge again. There is no evidence whatever of a second brood. The larvæ contained in stored fruit leave it and go into the pupa state in the barrels or bin, and under favorable conditions probably come out the following spring.

REMEDIES.

USELESS METHODS.

1. Spraying early in the season when the apples are small would do no good as the flies are not on the wing until July, when the early fruit is fully half or two-thirds grown, and too large to spray with safety.

2. Though in confinement the flies are very fond of sugar, yet

sweets poisoned with arsenious acid and corrosive sublimate, and placed on paper in shallow pans in the trees, failed to attract them.

3. Sticky fly papers seem to be useless. We exposed several sheets in the branches of a tree where the flies were thick, for three days, and only took a *single* Trypeta fly.

PREVENTIVE MEASURES.

1. Keep the orchards in grass and in the fall or spring burn under the trees to destroy the pupæ that are about the grass roots.

2. If the orchard is in cultivation the conditions are favorable for the maggots to go into the ground, but they never go deeper than an inch and deep spading or plowing in the spring would destroy them.

3. Orchards on sandy soil and in sheltered places with a southern exposure are worse affected. In planting orchards such conditions might be avoided.

4. Prevent by legal enactment the importation of foreign fruit from localities known to be infested. The pest was undoubtedly introduced into the State by importation of foreign apples. And each year there is a new invoice from Mass. in *imported early fruit*. We saw in the Orono market to-day a barrel of early sweet apples from Mass. literally alive with nearly full grown *Trypeta maggots*. No matter what methods are adopted to check this pest they will prove futile if each year in all the towns of the State maggots by the hundreds are thrown upon the ground in worthless infested foreign fruit.

DIRECT METHODS.

1. The flies are very stupid although they appear otherwise. When resting on the leaves or apples they can readily be taken with a small insect tube or bottle. By placing the mouth cautiously over them, they are not disturbed, and soon crawl inside. We took thirty this way from a single tree in an hour and a half. Making no allowance for mishaps and supposing a fly lays three hundred eggs and one-half of the flies are females, the progeny of a single fly the third season would be capable of laying nearly seven million eggs. The killing of even a few flies would materially lessen the number and hold the pest in check.

2. The fact that the larvæ do not leave the fruit before it is ripe and are still found in abundance in the windfalls, would indicate the most vulnerable points in the life history of the insect and suggest two methods of checking the pest, viz.: Taking

care that the larvæ in the gathered fruit be not allowed to transform, and destroying the windfalls. The apples gathered for home consumption and for market may contain many maggots, as our observations show the larvæ are still in the fruit when ripe. The chances that these larvæ find the conditions for development are much less than with those that go into the ground from the windfalls, but the pest may be spread through marketed fruit or be perpetuated from fruit stored or used at home.

a. Infested apples in market places are a fruitful source of the pest, and fruit dealers should be required to burn or bury all apple refuse and not throw it on the ground.

b. The maggots in stored apples soon leave them and go into the pupa state in the barrels or bins. If marketed the pupæ go with the fruit in the barrel and may spread the pest. In bins and barrels in the cellar the pupæ no doubt retain their vitality and the flies emerge in the spring. As a precaution the bins should be carefully swept and the barrels shaken into a tight vessel and the refuse buried or burned. Apple refuse from home use should be destroyed and not thrown on the ground.

c. The maggots are not able to crawl out of a box and the refuse from market places, &c., could be thrown into a tight box or barrel and the maggots prevented from going into the ground. The refuse could occasionally be buried a foot or so deep.

3. Thorough and universal destruction of the windfalls is the most hopeful means of checking the pest. To carefully gather the fallen fruit every day from the early and later varieties from Aug. 1st until Nov. 1st and burn or feed it, would destroy many of the maggots. Sheep or hogs might be allowed the range of the orchard to eat the windfalls. *To leave the windfalls on the ground would favor the most rapid multiplication of the pest.* It is some trouble to gather the windfalls but it would be little compared with the benefits derived, if the pest can be checked. This fly annually destroys much fruit in some parts of the State and its ravages are increasing, and it threatens, unless checked, to be the most serious pest to apple growers. Its ravages are somewhat circumscribed but it will spread unless checked. Such a serious enemy needs concerted and determined action. The importance of rigidly adhering to this method for at least two years cannot be to strongly urged upon fruit growers whose orchards are infested.

4. If the above methods do not succeed there is a radical one that cannot fail. The destruction of the entire apple crop for one

season in the infested districts of the State by giving the flies no place to rear their maggots would about destroy the pest. We do not think this will be necessary if the careful destruction of windfalls and infested fruit is practiced. Should such a radical means be necessary the flies could be allowed to deposit their eggs and the fruit approach maturity when it could be gathered and fed and not prove a serious loss.

SUMMARY.

1. Thoroughly and promptly destroy all refuse from infested fruit, apple pomace, waste about the house, etc.

2. Promptly destroy windfall apples and infested fruit.

3. Destruction should be immediate after the first of August, and nothing short of deep burying, burning or feeding to swine or cattle will be effective.

4. These precautions should be universally adopted.

5. The sale or importation of infested fruit should be prohibited.

THE POTATO ROT.

PHYTOPHTHORA INFESTANS, DEBARY.

(*Peronospora infestans*, *Mont.*)

PROF. F. L. HARVEY.

We are daily receiving specimens of potato tops and leaves badly infested with the above disease, and believe the information given below will be of general interest.

LIFE HISTORY.

This fungus lives over winter in the form of resting or winter spores (oosporæ) which are found in the stems, leaves and tubers. The stems and leaves decay leaving the resting spores which retain their vitality in the ground, and from these, or from spores in the tubers, the disease starts the following spring. The fungus is deep seated in the stem and leaves of the potato, and later affects the new tubers. During the summer and fall it appears on the surface as a white mildew, which upon examination will be found composed of branching pedicils (conidiophores), bearing numerous minute white oblong bodies, the summer spores (conidia) of the fungus. These summer spores are carried by the

wind to other parts of the field, light on the plants, germinate, enter and augment the disease. During the summer, new winter spores are formed within the stems, leaves and tubers, completing the life history.

REMEDIES.

The methods of treatment are direct and preventive, from the fact that the parasite is internal and only appears at the surface while producing summer spores. The methods must be largely preventive.

DIRECT METHODS.

Any means by which the growth of the *summer spores* can be checked, would prevent the spread of the disease from plant to plant during the season, and prove beneficial.

The following solutions have been tried in France and in New Jersey with apparently satisfactory results and we would recommend them for trial in Maine:

SOLUTIONS.

No. 1.—Mix 1 qt. of strong ammonia water (hartshorn) with 3 ozs. of carbonate of copper. Stir rapidly until a clear liquid is produced. When ready to use it, dilute to 22 galons with water. Apply with a spraying apparatus or force pump.

No. 2.—Dissolve 1 lb. sulphate of copper (blue stone) in 2 gallons of hot water. When dissolved and cool add 1 1-2 pints of commercial ammonia water. Dilute to 22 gallons with water. Apply as stated above.

No. 3.—Dissolve 6 lbs. copper sulphate in 16 gallons water. Shake 4 lbs. of fresh lime into 6 gallons of water. When cool mix the above solutions slowly and thoroughly and apply as stated above.

NOTE.

Any spraying apparatus will answer. Select the recipe for which the material can be readily obtained. Spray as soon as the disease begins to show as a whitish mildew, or the leaves begin to blacken. We would be pleased to have a report from those who try these mixtures.

PREVENTIVE METHODS.

1. Burn the tops and leaves in the fall after the crop is gathered, to destroy the winter spores contained in them.

2. Gather all the small potatoes, for if allowed to decay in the field the winter spores in them will start the disease the

following summer.

3. Select seed for planting, if possible, from fields or localities exempt from the disease the previous season.

4. Rotate the potato crop, as the winter spores germinate the following spring and finding no food-plants must perish.

5. Burn all decayed potatoes taken from the cellar or bins and other potato refuse—do not throw them on the compost heap as the spores retain their vitality and are spread far and wide with the manure.

6. The winter spores do not germinate very early in the spring. The planting of early varieties that mature before the parasite can get a start, has been recommended.

7. If cut seed is used, the surface should be allowed to dry, for when placed in the ground the winter spores would find ready entrance to the tubers through the freshly cut surface.

REMARKS.

If varieties of potatoes can be found less liable to attack they should be selected. We believe that a *faithful* and *universal* observance of the preventive methods suggested will go far toward relieving potato growers of this pest. We would like to hear from any into whose hands this bulletin may fall as to whether preventive methods are practiced.

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INSPECTION OF FERTILIZERS.

The inspection of fertilizers by the Maine Experiment Station for the year 1891 has required the analysis of sixty-four brands of mixed fertilizers and two brands of bone, involving the selection of one hundred and thirty-five samples. The number of brands inspected in 1890 was sixty-four. In order to secure these samples, it has been necessary to send an agent into nearly every section of the State, and during the present season he has occupied the equivalent of the entire time of a month in constant travel. Samples were taken in thirty-two cities and townships, often at several points in the same township. An effort is made to begin this work in March, but it is usually found that new goods have been shipped to but few places so that a successful canvass of the State can not be carried on until April, therefore the completion of the sampling and analytical work can not be reached until late in June. It will be noticed that three samples of each brand have not been secured in all cases.

In general this has been owing to the following causes: Selling of the fertilizer at but very few points, and finding only the goods held over from last year's sales in the hands of nearly all the agents visited.

SELECTION OF SAMPLES.

Samples for 1891 were selected by Mr. W. J. Holden, an agent of the Station, acting under its instructions. The samples were drawn from three or four packages, mostly one hundred pound bags, so that in all cases where three samples were taken the analysis represents from nine to twelve packages of the goods.

The drawing of the samples is accomplished by means of a sampling tube which can be made to reach every portion of the package, and as several drafts are made from each package, it is readily seen that the method of taking samples is a very thorough one, and there is no good reason for supposing that the contents of the glass jar that is forwarded to the Station does not fairly represent the goods sampled. In every instance a sample exactly

similar in composition to the one taken to the station is left in the hands of the agent selling the goods, thus giving the manufacturers an opportunity, by procuring an analysis of this sample, to check the analytical work of the Station.

The Trade Values of Fertilizers for 1890.

The trade values given below which are used by this Station are those "agreed upon by the experiment stations of Massachusetts, New Jersey, and Connecticut for use in their respective states during 1891. The valuations obtained by use of the following figures will be found to agree fairly with the *average retail price* at the large markets of standard raw materials such as:"

Sulphate of Ammonia,	Azotin,
Nitrate of Soda,	Ammonite,
Dried Blood,	Dry Ground Fish,
Muriate of Potash,	Bone or Tankage,
Sulphate of Potash.	Ground So. Carolina Rock,

Plain Superphosphates.

	Cts. per lb.
Nitrogen in ammonia salts	18½
nitrates	14½
Organic nitrogen in dry and fine ground fish, meat and blood	15½
in cotton seed meal and castor pomace	15
in fine bone and tankage	15
in fine medium bone and tankage	12
in medium bone and tankage	9½
in coarser bone and tankage	7½
in hair, horn shavings and coarse fish scrap	7
Phosphoric acid, soluble in water	8
" in ammonium citrate	7½
in dry ground fish, fine bone and tankage	7
in fine-medium bone and tankage	5½
in medium bone and tankage	4½
in coarser bone and tankage	3
Potash as high-grade Sulphate and in forms free from Muriate (or Chlorides)	5½
as muriate	4½

"These trade values are the average prices at which in the six months preceeding March the respective ingredients could be bought at retail for cash in our large markets, Boston, New York and Philadelphia, in the raw materials which are the regular source of supply. They also correspond to the average wholesale prices for the six months ending March 1st, plus about 20 per cent. in case of goods for which we have wholesale quotations."

The sale of "standard raw materials" in Maine is too small to allow an estimation of values upon the basis of local market prices, so the figures as agreed upon in other New England States, where the subject is very ably and thoroughly studied, are taken for use by this Station.

The Valuation of Superphosphates and Mixed Goods.

These trade values are applied to the valuation of Superphosphates and all mixed goods, as follows:

It is assumed that the organic nitrogen of these goods has for its source such materials as dried blood, ground fish, or nitrogenous substances of equally good quality, unless a special examination of some particular brand shows that inferior material like leather has been used. Organic nitrogen in mixed goods is therefore valued at fifteen and one-half cents per pound. As nitrogen in nitrates is rated for 1891 at only a cent less per pound than organic nitrogen, and as with but few exceptions the nitrates are present in very small quantities, no difference has been made in computing the "estimated value" between organic and nitric nitrogen, but both have valued at fifteen and one-half cents. The small increase in the "estimated value" thus caused, while slightly favorable to certain manufacturers, can certainly do the consumer no serious harm. The nitrogen present in ammonia salts is reckoned at eighteen and one-half cents.

The insoluble phosphoric acid of mixed fertilizers is reckoned at two cents per pound, coming as it does largely from mineral phosphates, and in any case being much the least valuable portion of the original material.

The potash is valued at the price of that ingredient in the muriate, unless the chlorine present in the fertilizer is not sufficient to combine with it, in which case the excess of potash is reckoned at the price of the sulphate.

The valuation of a fertilizer is obtained by multiplying the percentages of the several ingredients by twenty (which gives the pounds per ton), and these products by the prices per pound, and the sum of the several final products is the market value of the fertilizing ingredients in one ton. For instance the "station valuation" of a certain fertilizer was obtained as follows:

2.34	per cent.	Nitrogen	equal	46.8	lbs.	per ton	@	15½cts.....	$7.25
5.05	"	Sol. phos. acid	"	101.0	lbs.	" "	@	8 cts.....	8.08
1.48	"	Rev. " "	"	29.6	"	" "	@	7½cts.....	2.22
1.96	"	Insol. " "	"	39.2	"	" "	@	3 cts.....	1.18
5.12	"	Potash	"	102.4	"	" "	@	4½cts.....	4.61
Valuation.....									$23.34

Change in Method.

In past years separate analyses have been made of the three samples representing the same fertilizer. This year and last, equal quantities of the three samples have been mixed, and an analysis of this mixture has been assumed to give the same result as would be reached by averaging the analyses of the three samples, a method which is undoubtedly correct.

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at	Station Number.
784	Allen Fertilizer	American Mf'g Co., Boston, Mass.,	Saco	784
738	Allen Corn Fertilizer	" " " "	Caribou	738
787	Allen Fertilizer for Lawn	" " " "	Saco	787
737	Allen Potato Fertilizer	" " " "	Caribou	737
786			Saco	786
782	Americus Ammoniated Bone Superphosphate	Williams & Clark Co., New York, N. Y.	Kennebunk	782
796			Portland	796
806			Oxford	806
770	Bay State Superphosphate	J. A. Tucker & Co., Boston, Mass.,	Dexter	770
789			Knightsville	789
731	B. D. Sea Fowl Guano	Bradley Fertilizer Co., Boston, Mass.,	Presque Isle	731
776			Gorham	776
778			Alfred	778
811	Bowker's Ammoniated Bone Phosphate	Bowker Fertilizer Co., Boston, Mass.,	Bridgton	811
720	" Hill and Drill Phosphate	" " " "	Bowdoinham	720
761			Foxcroft	761
766			Dexter	766
817	" Potato Phosphate	" " " "	Richmond	817
721	" Sq. Brand, Bone and Potash	" " " "	Bowdoinham	721
760	" Sure Crop Bone Phosphate	" " " "	Foxcroft	760

RESULTS OF ANALYSES.

Station Number.	Brand.	Moisture %	Nitrogen %	Phosphoric Acid. Soluble %	Reverted %	Insoluble %	Total %	Available %	Potash %	Station Valuation. Value of nitrogen $	Value of phosphoric acid $	Value of potash $	Total valuation $
784	Allen Fertilizer	13.65	2.36	4.96	1.68	2.10	8.74	6.64	4.59	7.79	11.30	4.13	23.22
738	Allen Corn Fertilizer	15.71	2.39	4.86	1.96	1.82	8.64	6.82	4.91	8.00	11.44	4.42	23.86
787	Allen Fertilizer for Lawns	17.92	2.59	4.20	1.56	2.67	8.43	5.76	4.14	8.57	10.13	3.73	22.43
737	Allen Potato Fertilizer	16.08	2.46	4.34	1.65	2.16	8.15	5.99	4.73	8.12	10.27	4.26	22.65
782	Americus Amm. Bone Superphosphate	12.59	2.56	6.95	2.82	2.28	12.05	9.77	2.24	7.94	16.26	2.02	26.22
779	Bay State Superphosphate	14.14	2.59	1.94	5.57	3.66	11.17	7.51	2.96	8.03	12.91	2.66	23.60
731	S. D. Sea Fowl Guano	13.26	2.45	6.49	2.38	1.93	10.80	8.87	3.05	7.59	14.72	2.74	25.05
811	Bowker's Amm. Bone Phosphate	10.30	2.57	6.86	2.21	2.09	11.16	9.07	2.00	7.97	15.13	1.80	24.90
736	" Hill and Drill Phosphate	10.88	2.65	6.87	2.55	3.19	12.59	9.40	2.15	8.21	16.05	1.92	26.18
817	" Potato Phosphate	13.40	2.01	5.42	4.57	3.93	13.92	9.99	4.80	6.24	17.00	4.31	30.55
721	" Square Brand Bone and Potash	5.76	1.54	1.91	5.16	8.00	15.07	7.07	2.93	4.77	14.02	2.69	20.88
736	" [illegible] Bone Phosphate	12.62	.98	7.09	3.54	3.95	14.57	10.62	1.53	3.04	18.2	0.99	22.24

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at	Station Number.
689 775	Bradley's Complete Manure	Bradley Fertilizer Co., Boston, Mass.	Bangor Gorham	689 775
690 713	Bradley's Eureka Seeding Down Fertilizer	" " " "	Bangor Belfast	690 713
691 714 725	" Potato Manure	" " " "	Bangor Belfast Augusta	691 714 725
692 712 726	" X. L. Superphosphate	" " " "	Bangor Belfast Augusta	692 712 726
820	Buffalo Fertilizer	Milsom Rendering and Fert. Co., East Buffalo, N. Y.	Gardiner	820
753	" Hop, Tobacco and Potato Phosphate	" " " " " " "	Houlton	753
765 771	" New Rival Amm. Superphosphate	Wheeler & Sheldon, General Agents, Rutland, Vt.	Dexter Windham Cr.	765 771
755 793 837	Clark's Cove Bay State Fertilizer	John S. Reese & Co., New Bedford, Mass.	Houlton Portland Bangor	755 793 837
715 836	" G. G. Fertilizer	" " " " "	Rockland Bangor	715 836
779 790	" Bay State Seeding Down Fertilizer	" " " " "	S. Berwick Portland	779 790

RESULTS OF ANALYSES.

Station Number.	Brand.	Moisture %	Nitrogen %	Phosphoric Acid. Soluble %	Reverted %	Insoluble %	Total %	Available %	Potash %	Station Valuation. Value of nitrogen $	Value of phosphoric acid $	Value of potash $	Total valuation $
689	Bradley's Complete Manure	11.25	3.69	5.85	2.44	2.25	10.54	8.29	6.49	11.90	13.92	5.84	31.66
690	" Eureka Seeding Down Fertilizer	9.04	2.06	2.61	2.94	7.00	12.55	5.55	2.31	6.39	11.39	2.08	19.86
691	" Potato Manure	12.83	2.76	4.99	2.23	2.15	9.37	7.22	5.14	8.56	12.18	4.63	25.37
692	" X. L. Superphosphate	13.77	2.71	7.39	2.94	1.60	11.93	10.33	2.21	8.83	16.87	1.99	27.69
820	Buffalo Fertilizer	8.67	2.38	5.28	1.32	2.43	9.03	6.60	1.41	7.38	11.40	1.27	20.05
753	" Hop, Tobacco and Potato Phosphate	9.93	2.43	5.35	1.47	2.17	8.99	6.82	4.92	7.53	11.63	4.43	23.59
765	" New Rival Amm. Superphosphate	12.10	1.46	6.05	3.34	2.11	11.50	9.39	1.31	4.52	15.53	1.18	21.23
755	Clark's Cove Bay State Fertilizer	14.84	2.70	4.16	5.58	.93	10.67	9.74	2.16	8.66	15.40	1.94	26.00
715	" G. G. Fertilizer	13.67	1.93	3.97	6.49	.63	11.09	10.46	1.54	5.98	16.33	1.39	23.70
779	" Bay State Seeding Down Fertilizer	12.28	1.81	3.07	4.71	4.54	12.32	7.78	2.78	5.61	13.82	2.50	[illegible]

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at	Station Number.
769, 772, 777	Crocker's Amm. Corn Phosphate	Wheeler & Sheldon, Gen'l Agents, Rutland Vt.	Dexter, Windham Ctr., S. Berwick	769, 772, 777
688, 710	Cumberland Bone Superphosphate	Cumberland Bone Co., Portland, Me.	Bangor, Belfast	688, 710
730, 750, 818	Cumberland Potato Fertilizer	" " " " "	Presque Isle, Ft. Fairfield, Richmond	730, 750, 818
827	Cumberland Seeding Down Fertilizer	" " " " "	Skowhegan	827
719, 764, 826	Dirigo Fertilizer	Sagadahoc Fertilizer Co., Bowdoinham, Me.	Bowdoinham, Dexter, Skowhegan	719, 764, 826
751	Economical Bone Fertilizer	Williamson & Co.	Ft. Fairfield	751
728, 821	E. F. Coe's Amm. Bone Superphosphate	E. Frank Coe, New York, N. Y.	Augusta, Skowhegan	728, 821
706, 729, 752	E. F. Coe's Grass and Grain Superphosphate	" " " " "	Belfast, Augusta, Houlton	706, 729, 752
711, 746, 822	E. F. Coe's High Grade Amm. Bone Superphos	" " " " "	Belfast, Ft. Fairfield, Skowhegan	711, 746, 822
747	E. F. Coe's Potato Fertilizer	" " " " "	Ft. Fairfield	747

RESULTS OF ANALYSES.

Station Number.	Brand.	Moisture %	Nitrogen %	Phosphoric Acid.					Potash %	Station Valuation.			
				Soluble %	Reverted %	Insoluble %	Total %	Available %		Value of nitrogen $	Value of phosphoric acid $	Value of potash $	Total valuation $
769	Crocker's Amm. Corn Phosphate	12.50	2.14	5.35	4.85	2.20	12.40	10.20	1.36	6.63	16.71	1.22	24.56
688	Cumberland Bone Superphosphate	9.12	2.31	5.00	5.91	3.42	14.33	10.91	2.28	7.16	18.23	2.38	27.77
730	Cumberland Potato Fertilizer	8.59	2.81	4.76	5.56	3.13	13.45	10.32	6.43	8.71	17.33	5.79	31.71
827	" Seeding Down Fertilizer	6.09	1.59	2.48	6.11	10.52	19.11	8.59	.90	4.93	17.33	.81	23.37
719	Dirigo Fertilizer	6.40	3.62	.08	1.58	3.46	5.12	1.66	4.20	11.22	3.88	3.78	18.88
751	Economical Bone Fertilizer	7.32	1.02	4.40	2.30	1.13	7.83	6.70	2.32	3.16	10.94	2.09	16.19
728	E. F. Coe's Amm. Bone Superphosphate	10.71	1.74	7.93	2.15	1.70	11.78	10.08	1.20	5.39	16.59	1.21	23.19
706	" Grass and Grain Fertilizer	14.16	.60	9.59	2.23	1.06	12.88	11.82	1.24	1.86	19.10	1.36	22.32
711	" High Grade Amm. Bone Superphosphate	9.36	2.36	8.29	2.12	1.39	11.80	10.41	2.12	7.74	17.00	2.33	27.07
747	" Potato Fertilizer	10.24	2.24	7.00	1.32	1.20	9.52	8.32	5.87	7.36	13.66	5.28	26.30

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at	Station Number.
767	E. F. Coe's Standard Brand	E. Frank Coe, New York, N. Y.	Dexter	767
695	Farrar's Potato Phosphate	F. S. Farrar & Co., Bangor, Me.,	Bangor	695
696	" Superphosphate	" " " " "	Bangor	696
839			Brewer	839
722	Gloucester Fish and Potash	Bowker Fertilizer Co., Boston, Mass.,	Bowdoinham	722
759	King Phillip's Alkaline Guano	John S. Reese & Co., New Bedford, Mass.,	Dover	759
792			Portland	792
833			Oxford	833
756	May Flower Fertilizer	" " " "	Houlton	756
705	Nobsque Guano	W. D. Stewart & Co., Boston, Mass.,	Belfast	705
800			Portland	800
823	Original Coe's Superphosphate of Lime	Bradley Fertilizer Co., Boston, Mass.,	Skowhegan	823
741	Pilgrim Fertilizer	John S. Reese & Co., New Bedford, Mass.,	Caribou	741
754			Houlton	754
780			S. Berwick	780
733	Potato, Tobacco and Hop Phosphate	Wheeler & Sheldon, Gen'l Agents, Rutland, Vt.,	Presque Isle	733
749			Ft. Fairfield	749
768			Dexter	768
698	Potato Phosphate	Williams & Clark Co., New York, N. Y.,	Belfast	698
739			Caribou	739
781			Kennebunk	781
805			Oxford	805

RESULTS OF ANALYSES.

Station Number.	Brand.	Moisture %	Nitrogen %	Phosphoric Acid.					Potash %	Station Valuation.			
				Soluble %	Reverted %	Insoluble %	Total %	Available %		Value of nitrogen $	Value of phosphoric acid $	Value of potash $	Total valuation $
767	E. F. Coe's Standard Brand	10.07	1.76	8.21	2.07	1.39	11.67	10.28	1.10	5.46	16.83	1.21	23.50
695	Farrar's Potato Phosphate	12.16	2.56	4.76	4.86	3.11	12.73	9.62	1.89	8.20	16.15	1.70	26.05
696	" Superphosphate	10.52	2.76	5.95	4.06	3.04	13.05	10.01	1.87	8.56	16.83	1.68	27.07
722	Gloucester Fish and Potash	11.45	1.01	6.74	3.87	3.86	14.47	10.61	1.08	3.13	18.12	.97	22.22
759	King Phillip's Alkaline Bone	12.45	1.80	3.17	5.02	3.86	12.05	8.19	2.90	5.58	14.14	2.61	22.33
756	May Flower Fertillzer	12.05	2.21	5.54	3.80	3.25	12.59	9.34	2.07	6.85	15.86	1.86	24.57
705	Nobsque Guano	4.87	1.15	6.17	2.22	1.71	10.10	8.39	1.72	3.56	13.88	1.92	19.36
823	Original Coe's Superphosphate of Lime	10.15	2.29	7.37	2.02	2.42	11.81	9.39	2.41	7.10	15.79	2.17	25.06
741	Pilgrim Fertilizer	14.62	1.81	4.26	4.48	2.88	11.62	8.74	2.42	5.61	14.69	2.18	22.48
733	Potato, Tobacco and Hop Phosphate	12.54	2.13	6.51	3.25	2.41	12.17	9.76	3.16	6.60	16.25	2.84	25.69
698	Potato Phosphate	11.26	2.74	5.10	1.99	2.00	9.09	7.09	4.77	8.49	11.94	4.29	24.72

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at	Station Number.
736	Powell's Prep'd Chemicals for Potatoes and Veg.	W. S. Powell & Co..	East Washburn	736
799	Quinnipiac Grass Fertilizer.....	Quinnipiac Grass Fertilizer Co., New London, Conn.	Portland.....	799
773 783 788	" Phosphate.....	" " " " " "	Gorham..... Biddeford..... Knightsville...	773 783 788
701 732 745	" Potato Manure.....	" " " " " "	Belfast..... Presque Isle .. Ft. Fairfield..	701 732 745
774 797	" Seeding Down Manure.....	" " " " " "	Gorham..... Portland.....	774 797
791	Reese Concentrated Potato and Corn Manure...	John S. Reese & Co., New Bedford, Mass.,	Portland.....	791
699 801	Royal Bone Phosphate.....	Williams & Clark Co., New York, N. Y.,	Belfast..... Portland.....	699 801
744 807 819	Sagadahoc Special Potato Fertilizer..	Sagadahoc Fertilizer Co., Bowdoinham, Me.,	Ft. Fairfield. .. So. Paris..... Richmond.....	744 807 819
716 717 808	" Superphosphate.....	" " " " "	Bath..... ..... Bowdoinham .. So. Paris.....	716 717 808
697 735 740	Soluble Pacific Guano.....	W. D. Stewart & Co., Boston, Mass..	Belfast..... .... Presque Isle. .. Caribou.....	697 735 740

RESULTS OF ANALYSES.

Station Number.	Brand.	Moisture %	Nitrogen %	Phosphoric Acid. Soluble %	Reverted %	Insoluble %	Total %	Available %	Potash %	Station Valuation. Value of nitrogen $	Value of phosphoric acid $	Value of potash $	Total valuation $
736	Powell's Prepared Chemicals for Potatoes and Vegetables	11.04	1.77	5.33	1.20	.52	7.05	6.53	6.38	6.15	10.51	5.74	22.43
799	Quinnipiac Grass Fertilizer	21.97	3.41	2.72	4.94	1.91	9.57	7.66	2.91	10.57	12.52	2.62	25.71
773	" Phosphate	16.68	2.98	3.13	9.19	1.84	14.16	12.32	1.86	9.49	19.52	1.67	30.68
701	" Potato Manure	11.17	2.71	5.32	1.78	1.84	8.94	7.10	5.17	8.40	11.92	4.65	24.97
774	" Seeding Down Manure	16.12	1.45	4.35	6.71	1.83	12.89	11.06	2.03	4.49	17.75	1.84	24.08
791	Reese Concentrated Potato and Corn Manure	12.90	3.04	4.38	3.18	.69	8.25	7.56	8.19	9.42	12.05	7.37	28.84
699	Royal Bone Phosphate	9.43	1.28	6.22	2.49	1.30	10.01	8.71	1.84	3.97	14.20	1.92	20.09
744	Sagadahoc Special Potato Fertilizer	9.28	3.37	4.58	1.06	.83	6.47	5.64	4.52	11.29	9.25	4.54	25.08
716	" Superphosphate	10.60	3.01	7.37	1.66	.67	9.70	9.03	2.49	9.94	14.54	2.24	26.72
697	Soluble Pacific Guano	12.42	2.76	6.74	2.39	2.26	11.39	9.13	2.62	8.56	15.26	2.36	26.18

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at	Station Number.
707, 804, 815	Standard A Brand Seeding Down Fertilizer....	Standard Fertilizer Co., Boston, Mass.,	Belfast.. .. .... / Cumberland Ct. / Portland	707, 804, 815
709, 743, 757, 802	" Fertilizer.....	" " " " "	Belfast .... / Fort Fairfield.. / Houlton. ..... / Cumberland Ct.	709, 743, 757, 802
708, 742, 803	" Guano.....	" " " " "	Belfast..... / Ft. Fairfield. .. / Cumberland Ct.	708, 742, 803
694, 724, 762	Stockbridge's Corn, Grain and Fod. Corn Manure	Bowker Fertilizer Co., Boston, Mass.,	Bangor.. ..... / Bowdoinham .. / Foxcroft	694, 724, 762
814	" Grass Top Dressing.	" " " " "	Bridgton	814
813	" Manure for Fruit..	" " " " "	Bridgton	813
809	" " " Beans.....	" " " " "	Harrison.....	809
785, 825	" " " Seeding Down.....	" " " " "	Saco..... .... / Skowhegan	785, 825
693, 734, 763, 812	" Potato and Vegetable Manure....	" " " " "	Bangor..... .. / Presque Isle... / Foxcroft .... .. / Bridgton.....	693, 734, 763, 812
758, 816, 824	Sturtevant's Granulated Tobacco and Sulphur..	F. C. Sturtevant, Hartford, Conn.,	Dover. .... / Portland. ..... / Skowhegan	758, 816, 824
810	World of Good Raw Bone Superphosphate	Thompson & Edwards Fertilizer Co.,	Harrison.....	810

RESULTS OF ANALYSES.

Station Number.	Brand.	Moisture %	Nitrogen %	Phosphoric Acid. Soluble %	Reverted %	Insoluble %	Total %	Available %	Potash %	Station Valuation. Value of nitrogen $	Value of phosphoric acid $	Value of potash $	Total valuation $
707	Standard A Brand Seeding Down Fertilizer	11.51	1.60	5.58	1.19	3.35	10.12	6.77	1.55	4.96	12.05	1.39	18.40
709	" Fertilizer	14.30	2.19	6.78	2.41	2.35	11.54	9.19	2.42	6.79	15.40	2.18	24.37
708	" Guano	11.75	1.17	5.95	2.39	2.25	10.59	8.34	1.87	3.63	14.00	1.68	19.31
694	Stockbridge's Corn, Grain and Fodder Corn Manure	10.41	3.22	6.35	1.90	2.71	10.96	8.25	4.83	9.98	14.09	4.35	28.42
814	" Grass Top Dressing	8.47	4.73	1.28	4.05	7.71	13.04	5.33	5.53	14.66	11.20	4.98	30.84
813	" Manure for Fruit	7.60	2.83	6.91	2.38	3.30	12.59	9.29	4.38	8.77	15.95	4.67	29.39
809	" " " Beans	10.25	3.43	6.01	2.44	2.10	10.55	8.45	6.86	11.10	14.12	6.18	31.40
785	" " " Seeding Down	9.35	3.19	4.52	2.68	4.91	12.11	7.20	3.91	9.89	13.21	3.52	26.62
693	" Potato and Vegetable Manure	10.67	3.39	5.42	4.27	2.06	11.75	9.69	5.65	10.51	15.89	5.08	31.48
758	Sturtevant's Granulated Tobacco and Sulphur	4.77	2.35				.83		7.38	7.28	1.00	8.11	16.40
810	World of Good Raw Bone Superphosphate	4.59	2.14	5.85	3.30	3.48	12.63	9.15	1.85	6.63	15.70	1.66	23.99

No one who is familiar with the published list of fertilizers that are sold in several states can have failed to notice, not only that there is great multiplicity of brands, but that the names of the various mixed fertilizers indicate that they are to be used for special purposes. We have fertilizers for no special purpose, but for general use, those for corn, for potatoes, for grain, for fruit, for lawns, for top dressing, for seeding down and for various other purposes, if we may regard the names as meaning anything. It is not known to what extent farmers give attention to these names, but it is hoped that they have already learned that they are largely a trade expedient by means of which manufacturers hope to increase their sales. To be sure, potato manure usually contains more than an average amount of potash, and seeding down manures more than the ordinary percentage of insoluble phosphoric acid, but this signifies nothing when we find how slight the difference is between certain corn fertilizers and certain potato "phosphates." These fertilizers are not compounded in accordance with any well defined principle.

No facts are known with regard to the composition of soils or the nutrition of plants which warrant the use of less phosphoric acid and more of nitrogen and potash in a fertilizer for beans than in one for potatoes, as is done in one case. In fact, if we are to judge this matter of special fertilizers by the composition of these goods as we find them in the market, the whole thing appears to be farcical or a species of humbuggery. It is just as sensible to buy some corn manures for use on potatoes, and some potato manures for use on corn as it is to apply them in accordance with their names. The great and controlling factor which should determine what fertilizers are to be purchased is the needs of the soil, and each farmer should purchase manure rich in potash or poor in potash, according to the teaching of his experience.

The Quality of the Nitrogenous Material in the Superphosphates sold in Maine.

In 1889, this Experiment Station tested the quality of the organic nitrogenous material found in the fertilizers sold in Maine, using the only method which appears to promise fairly reliable results.

There was published in connection with the results of the work of that year an explanation of the needs and methods of such a test, part of which is reproduced in this connection.

Experiment stations have assumed that the organic nitrogen of mixed fertilizers is supplied in the best forms, and have valued it accordingly, but it has been recognized, at the same time, that some way of detecting inferior forms is extremely desirable. The method for doing this which has received most attention, is based upon the different degrees of solubility of organic nitrogen compounds in a pepsin solution. The nitrogen of dried blood, dried flesh, cotton-seed meal and similar high grade nitrogenous materials, is very largely dissolved by digestion in a pepsin solution, while that of horn, hoof and leather is much less affected by this treatment.

In support of this statement, there is given below the results of experiments conducted in three different laboratories for the purpose of testing the value of this method. With regard to most of the materials used, these results are practically in accord.

SOLUBILITY OF CERTAIN NITROGENOUS MATERIALS IN PEPSIN SOLUTION.

MATERIALS USED.	Per Cent. of Total Nitrogen Dissolved as found by					
	Shepard & Chazal.		Conn. Expt. Sta.		Maine Expt. Sta.	
Dried Blood	99.8 78.6	98.2	96.8 97.9	97.3	97.3 93.3 97.6 95.1	95.8
Cotton Seed Meal	83.2 85.7 83.1	84.0	92.7			
Ground Bone			52. to 99.* av. 78.		68.3	
Dried Flesh	93.3		78.7 85.4 77.5	80.5	75.7 75.4 78.4	76.5
Dried Fish			58. to 72.† av. 66.			
Fish Scrap	88.6 84.6	86.6			59.2 82.6	70.9
Tankage	61.3				58.0 48.6	53.3
Wool Waste			4.8			
Leather	37.8		25.4 35.9 33.3	34.9	26.5 7.7	17.1
Horn and Hoof Meal			7.2 22.4 28.2	19.3	25.6	

* 20 samples. † 7 samples.

The degree of solubility for cheap and inferior "ammoniates" such as horn, hoof, leather and wool waste is seen to vary from 4.8 per cent. to 37.8 per cent., while in the case of dried blood, cotton-seed meal, dried and ground flesh, dried fish, fish scrap and ground bone the average percentages of the different trials range from 70.9 per cent. to 97.3 per cent.

It is shown by the Conn. Experiment Station* that mixing with these ammoniates mineral compounds of the kind and in the quantity that would be found accompanying them in superphosphates does not materially change their solubility in a pepsin solution, consequently it is fair to conclude that the solubility in a pepsin solution of the organic nitrogen of a superphosphate will show whether this ingredient is furnished largely in an inferior form.

It was found in 1889, that the percentage of nitrogen soluble in a pepsin solution varied in the several brands tested from thirty-eight to seventy-eight per cent. This variation most certainly indicated a radical difference in the character of the ammoniates used by the various manufacturers, and it was thought wise to repeat this work with the goods offered for sale in 1891. Not every brand of which samples have been taken in the market has been submitted to this test, but there has been selected for this purpose at least one brand from each manufacturer selling goods in the State. The work was performed by Mr. Merrill with the use of the following methods:

The sample taken to represent a brand of superphosphate was made up so as to represent the average of all the samples of that brand selected this season. This was done, for instance in the case of the Bay State Fertilizer, by weighing out equal quantities of Nos. 755, 793 and 837, and thoroughly mixing them in a mortar. One gram of substance was thoroughly leached with water and then submitted to the action of a pepsin solution in accordance with the method given below. The insoluble nitrogen of the residue was then determined.†

The percentages of organic nitrogen given are the total nitrogen minus the nitrogen as nitric acid and ammonia. The tables which follow explain themselves.

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† The method of treating the substances was briefly as follows: The pepsin solution was made by dissolving 5 grams of scale pepsin in 1000 c. c. of .2 per cent. hydrochloric acid. Two grams of the substance were digested for 12 hours on each of two consecutive days with 200 c. c. of this solution, at a temperature of 40 degrees C. During the time of digestion 2 c. c. of a ten per cent. solution of hydrochloric acid were added at regular intervals until the digestive fluid contained one per cent. of the acid.

[Report Conn. Experiment Station, 1885, pp. 120-121.]

	Per Cent. of Nitrogen in Fertilizer.				Solubility in Pepsin Solution.		
	Nitrogen as Nitric Acid.	Nitrogen as Ammonia.	Organic Nitrogen.	Total Nitrogen.	Organic Nitrogen Soluble in Pepsin. % in Fertilizer.	% of Org. Nitrogen Soluble in Pepsin Solution.	% of Total Nitrogen soluble in Water and Pepsin Solution.
Allen's Fertilizer for Lawn		.91	1.68	2.59	.59	35.1	57.9
Bay State Fertilizer		.49	2.21	2.70	1.54	69.7	75.2
Bowker's Potato Phosphate	.47		1.54	2.01	1.00	64.9	73.1
Bradley's Potato Manure	.37		2.39	2.76	1.50	62.8	67.8
Buffalo Hop, Tobacco and Potato Phosphate		.25	2.18	2.43	1.64	75.2	77.8
Buffalo Potato, Tobacco and Hop Phosphate		.26	1.87	2.13	1.12	59.9	64.8
Cumberland Bone Superphosphate	.26	.21	1.84	2.31	1.04	56.5	65.4
Dirigo Fertilizer		.22	3.40	3.62	1.48	43.5	47.0
E. Frank Coe's Potato Fertilizer		.70	1.54	2.24	.86	55.8	69.6
Farrar's Potato Superphosphate		.43	2.13	2.56	1.42	66.7	72.3
Nobsque Guano			1.15	1.15	.62	53.9	53.9
Original Bay State Superphos		.25	2.34	2.59	1.56	66.7	69.9
Powell's Prepared Chemicals for Potatoes and Vegetables	.57	1.11	.09	1.77	—	—	—
Quinnipiac Grass Fertilizer	.82	.32	2.27	3.41	1.18	52.0	68.3
Quinnipiac Phosphate	.46	.43	2.09	2.98	1.15	55.0	68.5
Quinnipiac Potato Manure	.61	.21	1.89	2.71	1.27	67.2	77.1
Sagadahoc Special Potato Fertilizer		1.40	1.97	3.37	.99	50.2	70.9
Sagadahoc Superphosphate for Hill and Drill		1.03	1.98	3.01	1.07	54.0	69.8
Standard A Brand Seeding Down		.30	1.30	1.60	.81	62.3	69.4
Standard Fertilizer		.22	1.99	2.19	1.21	60.8	64.4
Standard Guano		.16	1.01	1.17	.63	62.4	67.5
Stockbridge Manure, Corn, Grain and Fodder	1.41		1.81	3.22	1.20	66.3	81.1
Williams & Clark Potato Phos.	.47		2.27	2.74	1.52	67.0	72.6
World of Good Raw Bone Superphosphate			2.14	2.14	1.68	78.5	78.5

The solubility of the organic material in various fertilizers in a pepsin solution varies from thirty-five per cent. to seventy-eight per cent.

In the case of several brands, the figures are such as to cause grave doubts as to whether the manufacturers are not using what are regarded as low grade ammoniates, that is, ammoniates coming from such materials as hoof, horn, leather &c., of which we have reason to suppose that they will decompose slowly in the soil and are therefore poorly adapted for use with quickly growing plants. It is at least safe to affirm that with a large number of these fertilizers the solubility of the organic matter comes far short of that which dried blood, cotton seed meal, dried flesh and similar materials are known to have.

STATION EQUIPMENT.

The Maine Experiment Station, since its organization in 1885, has devoted a fair share of its income and of the time of its working force to a study of some of the practical problems pertaining to animal nutrition. During all this time the equipment for this work has been gradually improving, until it has become quite satisfactory for conducting experiments in determining the digestibility of cattle foods and in testing the economy of various methods and rations for producing meat and milk.

A description of the Station Barn is given here, not because its arrangement and equipment are regarded as especially good, but because the interest of those who are following the Station work may be increased possibly by a definite understanding of just how and where this work is done.

The Station Barn.

This is a building (see cut) one hundred feet long by forty feet wide. It consists of a basement, the first floor, which is devoted to space for tying animals and to other necessary rooms, and the second story, which gives sufficient room for the storing of fodder and numerous lots of experimental grain. The foundation of the barn, which constitutes the walls of the basement and which rests for its entire length upon a solid ledge, is built of broken stone and is thoroughly cemented on the outside and well filled with mortar on the inside.

The floor of the basement consists of solid ledge covered by a small amount of earth, and has sufficient inclination to entirely prevent any standing water, even if such were to come from outside drainage, which is not the case.

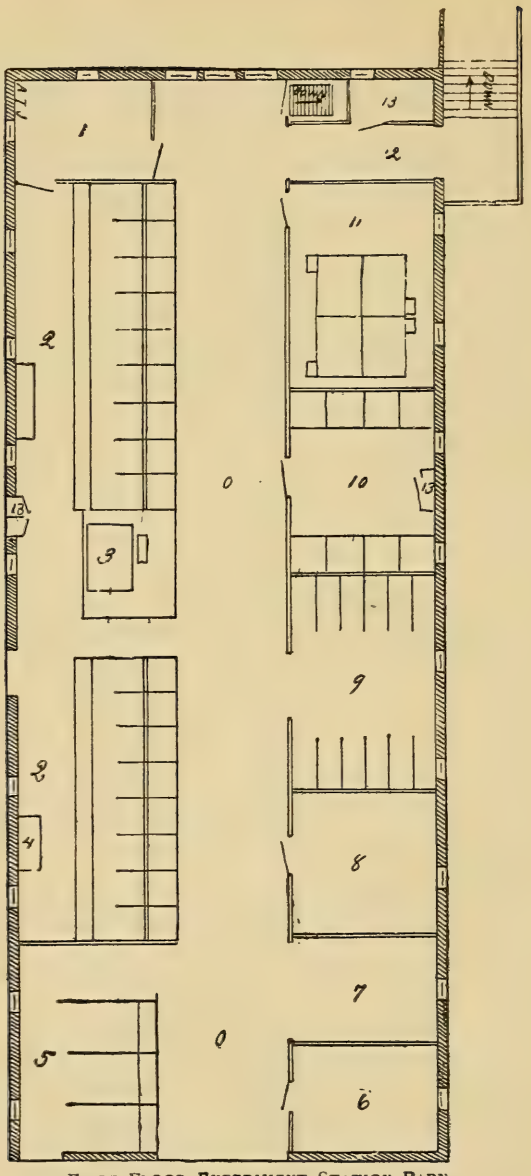
The first floor of the barn is occupied as follows (see Plate I):

(0) A driveway and floor for feeding which occupies the center of the entire length of the barn. This floor space is covered by an upper floor with the exception of about twenty feet at one end.

(1) A hospital in the southwest corner of the barn.

(2) A tie-up on the south side of the barn which has seventeen stalls. This tie-up is provided with scales (3) set in the floor for

PLATE I



FIRST FLOOR EXPERIMENT STATION BARN.

0. Driveway.
1. Hospital.
2. Cow Stable.
3. Scales.
4. Water.
5. Horse Stable.
6. Silo.
7. Storage.
8. "
9. Hay Bins.
10. Grain Room.
11. Digestion Room.

the purpose of weighing experimental animals. It is also supplied with running water (4). The stalls are built of birch and are so constructed as to give the animal the utmost ease in its movements. (See cut.) The manure drops through trap doors into the basement.

(5) Horse stalls to accommodate the horses of such station officers as live at a distance from the College buildings.

(6) The silo in the northeast corner which extends from the floor of the basement to the second floor above.

(7) Space for the storage of implements.

(8) A room for the storage of fertilizers, grains, etc.

(9) Small bins into which the hay rations of experimental animals are weighed.

(10) The grain room, equipped with a number of grain bins and scales for the weighing of rations.

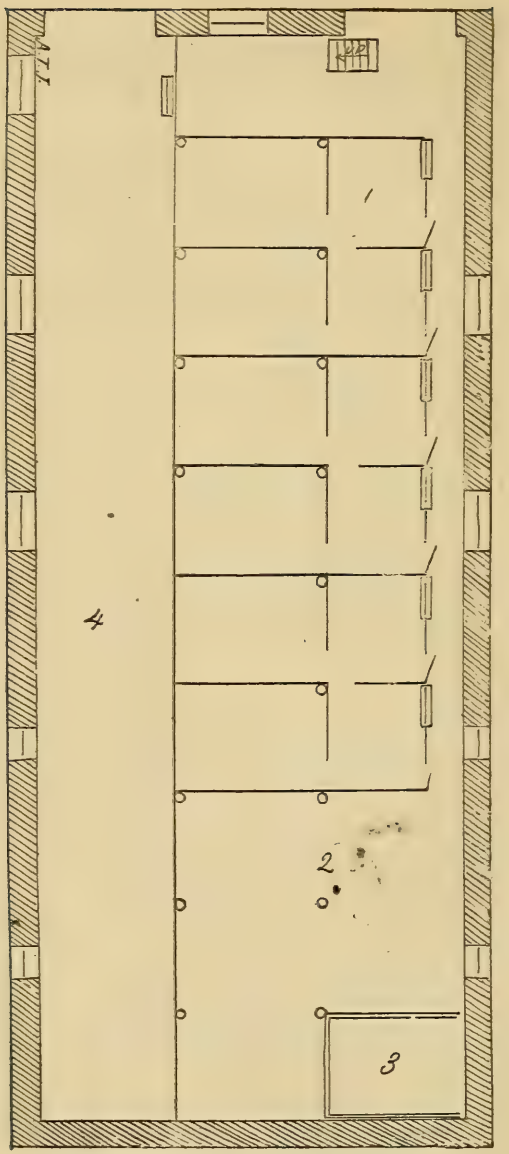
(11) A room devoted to digestion experiments.

The walls of these various rooms as well as the partitions between them and the feeding floor consist of spruce sheathing. The use of the second floor has already been stated. The hay or grain is taken from the load (which is driven into the end of the barn that is not floored over) by a fork, which, running on a track near the ridgepole of the barn, distributes the hay to any desired point.

Feeding Experiments with Cows and Other Bovines.

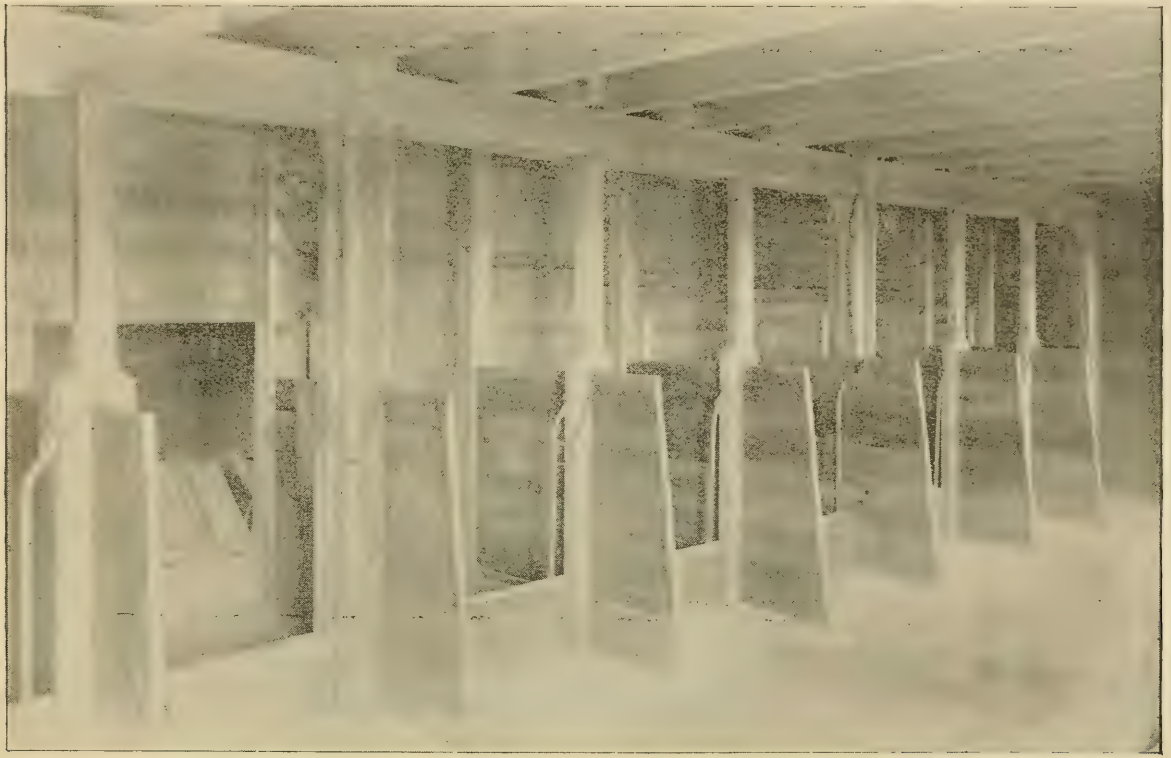
These experiments usually involve both the feeding of a fodder and a grain ration. The fodder, if hay, is generally weighed out in lots of fifty pounds and stored in the bins provided for that purpose. Each bin is set aside to the use of a certain animal, and a cow, for instance, is fed from her particular bin until it is necessary to weigh out a new portion of hay. By adopting this method it is possible to avoid such numerous weighings as would be required if the fodder was weighed each time the animal is fed. In the grain room are found boxes which are marked with either the numbers or names of the animals, into which each portion of grain is weighed. When this grain is fed it is turned into the stalls, the bottoms of which are so constructed that there is no waste. Generally the rations, both of fodder and grain, are entirely consumed, but if such is not the case, the uneaten portions are saved and weighed, so that it is possible to calculate the amounts actually eaten. If the experiment is with growing ani-

PLATE II.



BASEMENT EXPERIMENT STATION BARN.

1. Pig Pens.
2. Storage.
3. Silo.
4. Manure.



COW STALLS IN EXPERIMENT STATION BARN.

mals, not only is there a daily weighing of rations, but the weight of the animals must be ascertained at the beginning and end of the several feeding periods. The animals are usually weighed on several successive days and the average of these weights is taken as a basis for calculating the amount of growth.

If an experiment is being made with dairy cows, not only is it necessary to weigh the rations and also to keep a record of the weights of the cows, but the weight of each mess of milk must be recorded. The weights of milk are marked on prepared blanks which are hung in a convenient place behind the animals. In all such experiments the appetite and health of the animals are carefully watched and the results with any animal that is not in proper condition are not allowed to enter into the final published records. The experimental animals, whether young stock or dairy cows, are allowed a proper amount of exercise in a yard which lies on the sunny side of the barn. A portion of the partition which separates the tie-up from the feeding floor is hinged, so that one part can be let down and another part turned up. In this way, it is possible to give proper ventilation and to some extent, control the temperature where the animals are standing.

Swine Feeding Experiments.

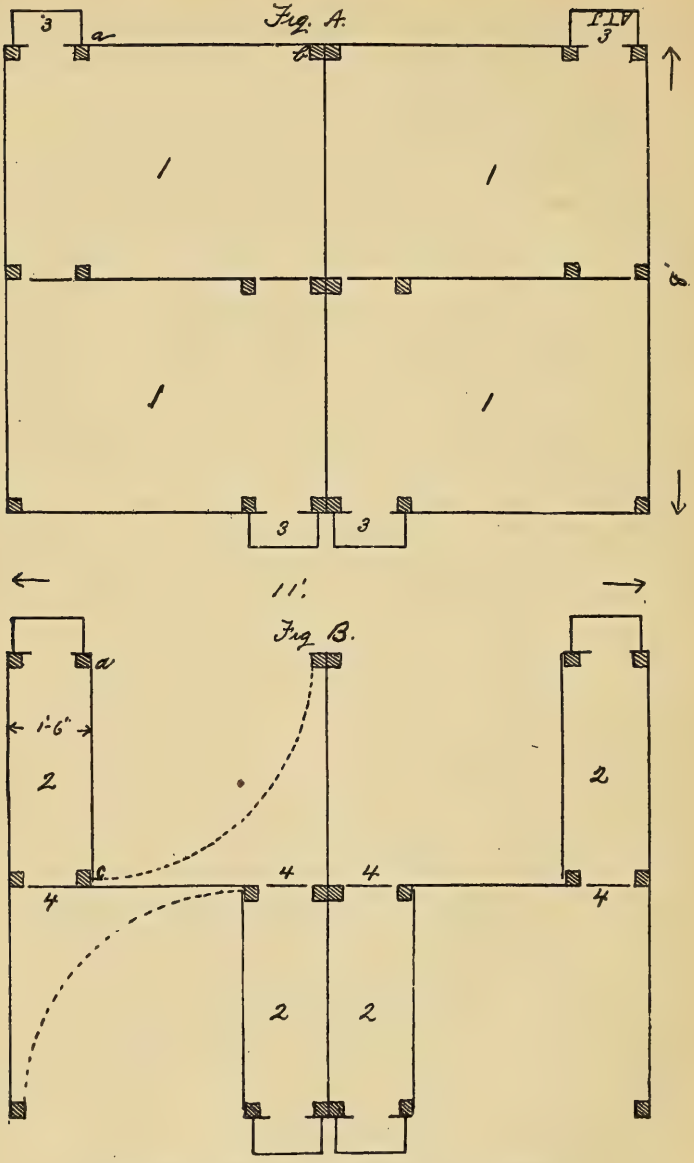
These experiments are to be carried on in the future in six pens which have lately been built in the basement (see Plate II). These pens are divided into two rooms which are connected by a sliding door, one room having a floor of spruce plank. This latter part is well littered with straw and is intended for the place where the animals shall eat and sleep. The feeding troughs are so arranged that by means of a swinging partition the animals can be excluded from them. This device prevents the troughs being filled with filth during the time when the animals are not eating, and allows the attendant to turn in the food without inconvenience. After the food is turned in, the partition is swung to the outside of the trough, and when the animal has finished his meal, is swung back again.

The Digestion Room.

The mechanical appliances which must be considered in connection with a digestion experiment, are

(1) The pen or stall in which the animal is kept.

PLATE III.



PENS FOR DIGESTION EXPERIMENTS WITH SHEEP.

1. Pens, with sheep at liberty.
2. " " " confined.
3. Feeding Boxes.
4. Sliding Panels

(2) The rubber bag and harness which are attached to the animal during the time that it is necessary to collect the excrements.

The form of the stall or pen depends upon the kind of animal used. The digestion trials made by this Station have been almost entirely with sheep, and the pen shown in the accompanying plate was devised here for use with this animal. The sides of these pens are 3'—9'' high and are built of four inch spruce sheathing, with spaces.

As can be seen by reference to Plate III, the pens are so constructed that four sheep can be used at one time. As shown in Fig. A, each pen has a floor space of twenty-two square feet.

In Fig. B nearly all of one side of each pen has been swung from the position *a b* to the position *a c*, forming a stall 18x48 inches in dimensions, in which the sheep can stand and lie at ease but cannot turn around.

It is well known to those familiar with the methods of digestion experiments that a feeding period of from twelve to fourteen days is necessary, at least the first seven days of which must be devoted to a preliminary feeding before it is safe to collect the excrement. During this first seven days the animal may have the liberty of the pen as shown in Fig. A. When, however, the excrement bags are attached it is necessary to confine the animals in the stalls as shown in Fig. B, either during the entire five days or at least while the contents of the bags are being removed.

During the last five days, while confined in the smaller pens, the animals stand upon a movable slat floor, the spaces between the slats allowing the urine to flow out of the way so that neither the animal nor the bags become soiled. The outer end of each of the small pens contains an aperture through which the animal's head has access to the feeding boxes which are attached outside. These feeding boxes are wooden boxes lined with zinc, which are extended upwards with galvanized iron to a height that entirely prevents the scattering of the food outside. The rear end of the smaller pens consists in part of a sliding panel, which allows the convenient removal of the contents of the excrement bags.

During the seven days that the dung is not collected the animals are freely bedded with dry, clean sawdust. When the bags are attached the bedding is removed and the floors thoroughly swept, so that it is possible to see whether any loss of dung has occurred.

The arrangement of these pens has so far proved entirely satisfactory, and is commended to those who desire to undertake digestion experiments.

The excrement bags in use by this Station consist on the inside of the ordinary rubber cloth which can be purchased at any drug store, and on the outside of bed ticking, which gives strength and durability. These bags are attached to the animal by means of a light harness. This harness is made as follows: A collar passes around the animal's neck, and a band around the body just back of the fore legs. To the neck collar are attached four straps which pass lengthwise of the body, two along the back and two between the fore legs. The straps slide through slots in the body band, and are attached to the bag on the back and under the belly just front of the hind legs. The lower end of the bag is not sewed together, but is closed when necessary by tying a string around it. In this way the bags can be emptied by simply untying the string and allowing the contents to drop into a dish placed underneath.



MAINE EXPERIMENT STATION BARN.

DIGESTION EXPERIMENTS.

The digestion experiments, the results of which are given in the following pages, were not wholly accomplished within the year 1891, but were in part performed during the latter part of 1890.

The materials which were made the subject of these experiments were produced on the College Farm in the summer of 1890, excepting, of course, the bran and gluten meal. The mere determination of digestion coefficients was not, in every case, the main object of the work. While a knowledge of the digestibility of these foods is of value in itself, here it was in large part essential to correct conclusions in regard to quite different questions.

Experimental Foods.

The foods whose digestibility was determined were the following:

CXXI. Hungarian Grass.
CXXVIII. Hungarian Hay (cxxi dried).
CXXVII. So. Corn Fodder.
CXXV. Field Corn Fodder.
CXXVI. Sweet Corn Fodder.
CXL. Timothy Hay.
CXLI. " "
CXXXIII. Sugar Beets.
CXXXII. Mangolds.
CXXX. Rutabagas.
CXXXI. English Flat Turnips.
CXXXIV. Gluten Meal.
CXXXV. Wheat Bran.

The gluten meal and wheat bran were purchased in the Bangor market and the other foods were produced by the Station.

Digestibility of Hungarian Grass.

Time of experiment, August and September, 1890.
Animals used, Sheep.
Daily ration, 2250 grams.
Total period, 12 days.
Feces collected, last five days.

A certain amount of the grass was cut daily, from which, after chopping, the rations were weighed. A portion of the fresh grass unchopped was also put aside each day and carefully spread for drying.

Samples for analysis were selected daily and were immediately dried in the laboratory by the aid of steam heat.

Analytical data.—The composition of the fresh grass is given below, as well as that of the water-free material.

Composition of Hungarian Grass.

	Fresh Grass.						Water-free Substance.				
	Water.	Ash.	Protein Nx 6 25	Fiber.	Nitrogen-free extract.	Fat.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
	%	%	%	%	%	%	%	%	%	%	%
CXXI, Hungarian Grass.....	75.29	2 29	2.73	7.58	11.29	.82	9.26	11.07	30.66	45.68	3.33

Composition of Feces from Hungarian Grass.

	Fresh Feces.		In 100 parts dry substance.				
	Water.	Dry substance.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
	%	%					
Sheep 1..	65.37	34.63	14.50	11.25	27.15	43.26	3.84
" 2.....	68.48	31.52	14.85	11.97	27.13	41.47	4.58
" 3.....	52.34	47.66	15.52	10.86	26.74	41.46	4.42
" 4.....	54.26	45.74	14.22	11.25	26.25	43.88	4.40

Weights of Food and Feces.

	Food eaten daily.		Feces excreted daily.	
	Green.	Water-free.	Fresh.	Water-free.
	grams.	grams.	grams.	grams.
Hungarian Grass, Sheep 1.....	2250	556	626	216.8
" " " 2.....	"	"	661	208.4
" " " 3.....	"	"	430	205.0
" " " 4.....	"	"	400.4	183.2

The digestibility of the Hungarian Grass as calculated from the preceding data was as follows :*

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Sheep, 1	61.	63.4	37.2	60.2	65.4	63.5	54.9
" 2	62.5	65.1	37.	59.4	66.8	66.7	47.8
" 3	63.1	65.2	42.5	63.6	67.2	64.8	50.5
" 4	67.	68.8	49.5	66.4	71.7	68.4	56.
Average	**63.4**	**65.6**	**41.5**	**62.4**	**67.8**	**65.8**	**52.3**

Digestibility of Hungarian Hay.

Time of experiment, November, 1890.

Animals used, Sheep.

Daily ration, 800 grams air dry hay.

Total period, 12 days.

Feces collected, last five days.

This hay was made from the grass used in the digestion experiment previously described; the grass was dried under cover by spreading it thinly on a scaffold.

Analytical data.—The tables below give the composition of the hay and feces and the weights of materials.

Composition of Hungarian Hay.

	Air dry hay.						Water-free substance.				
	Water.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
CXXVIII Hungarian Hay..	18.07	7.08	8.86	23.96	38.93	3.10	8.64	10.82	29.24	47.52	3.78

Composition of Feces from Hungarian Hay.

	Fresh Feces.		In 100 parts dry substance.				
	Water.	Dry substance.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
Hungarian Hay, Sheep, 1	53.29	46.71	12.89	12.42	26.54	44.24	3.90
" " " 3	51.23	48.77	12.87	12.11	27.11	44.68	3.83

* Tables showing the necessary calculations for these and other coefficients can be found in the appendix to this part of the report.

WEIGHTS OF FOOD AND FECES.

	Food eaten daily.		Feces excreted daily.	
	Air dry.	Water-free.	Fresh.	Water-free.
Hungarian Hay, Sheep 1	800	655.5	490	228.9
" " " 3	800	655.5	480	234.1

The following coefficients of digestibility were obtained with two sheep:

DIGESTIBILITY OF HUNGARIAN HAY.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Sheep, 1	65.8	66.8	47.9	59.9	68.5	67.4	63 9
" 3	64.3	65.9	46.9	60.	66.8	66 9	63.8
Average	**65.**	**66.3**	**47.4**	**60.**	**67.6**	**67.1**	**63.8**
Hung. Grass as previously found	63.4	65.6	35.5	62.4	67 8	65.8	52.3

DIGESTIBILITY OF CORN FODDER FROM SO. CORN, FIELD CORN AND SWEET CORN.

Time of experiment, October and November, 1890.

Animals used, sheep.

Total period, 12 days.

Feces collected, last 5 days.

A determination of the digestibility of the fodders from these varieties of corn was one of the necessary steps in an attempt* to study their relative yield of digestible material.

Several hundred pounds of the green fodder corn were selected from each variety at the time the crop was cut and weighed. These small lots were stored in such a manner that they would dry without moulding and where they were safe from the depredations of mice.

The partially dried fodder of the several kinds was finely

* The details of this experiment are given on subsequent pages.

chopped, thoroughly mixed, the daily rations weighed out, and samples at once taken to the laboratory, where the drying was completed by steam heat.

Analytical data.

COMPOSITION OF THE CORN FODDERS BEFORE DRYING.

	Green Corn.						Water-free substance.				
	Water.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
CXXVII, So. Corn.....	85.06	1.28	1.64	4.58	7.00	.44	8.55	10.99	30.66	46 87	2.92
CXXV, Field Corn.....	84.21	1.20	1.77	4.01	8.28	.53	7.62	11.20	25.42	52.45	3.31
CXXVI, Sweet Corn.....	83.85	1.13	2.18	4.14	8.08	.62	7.01	13.52	25.63	49.98	3.86

COMPOSITION OF FECES FROM THE CORN FODDERS.

	Fresh Feces.		In 100 parts dry substance.				
	Water.	Dry substance.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
So. Corn Fodder, Sheep 2.....	60.62	39.38	12.	12.42	25.87	46.81	2.76
" " " " 4.....	53.67	46.33	11.78	12.41	25.76	47.23	2.83
Field Corn Fodder, Sheep 1.....	59.90	40.10	11.78	14.08	21.36	49.48	3.30
" " " " 3.....	65.81	34.19	12.58	15.01	20.80	48.26	3.35
Sweet Corn Fodder, Sheep 2.....	72.01	27.99	14.42	17.52	19.34	46.04	2.68
" " " " 4.....	69.29	30.71	13.77	16.58	20.19	46.11	3.35

WEIGHTS OF FOOD AND FECES.

	Food eaten daily.		Feces excreted daily.	
	Green.	Water-free.	Fresh.	Water-free.
So. Corn, Sheep 2.....	3378.8	504.7	380.	149.6
" " " 4.....	3378.8	504.7	342.	158.4
Field Corn, Sheep 1.....	2553.2	403.2	283.4	113.6
" " " 3.....	2553.2	403.2	360.	123.1
Sweet Corn, Sheep 2.....	2521.	407.2	445.2	124.7
" " " 4.....	2521.	407.2	394.	121.

Below are given the coefficients of digestibility as found:

Digestion Coefficients of Corn Fodders.

	Dry substance.	Organic matter.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
So. Corn, Sheep 2	70.3	71.4	58.2	66.1	74.9	70.4	72.3
" " " 4	68.6	69.8	56.6	64.7	73.6	68.7	69.6
Average	**69.4**	**70.6**	**57 4**	**65.4**	**74.2**	**69.5**	**70.9**
Field Corn, Sheep 1	71.8	73.7	56.3	64.6	76.3	73.4	71.4
" " " 3	69.4	71.1	49.5	59.	75.	71.9	69.1
Average	**70.6**	**72.4**	**52.9**	**61.8**	**75.6**	**72.6**	**70.2**
Sweet Corn, Sheep 2	69.3	73.2	37.	60.2	76.9	71.8	78.3
" " " 4	70.2	73.9	41.9	63.5	76.6	72.5	74.5
Average	**69.7**	**73.5**	**39.4**	**61.8**	**76.7**	**72.1**	**76.4**

Digestibility of Timothy Hay.

Time of experiment, December, 1890, and February, 1891.

Animals, Sheep.

Daily rations, 700 grs.

Total period, 12 days.

Feces collected, last five days.

Two large lots of hay were taken from the mows, finely chopped and thoroughly mixed. The digestibility of this material was ascertained as work necessarily preliminary to a determination of the digestibility of various roots, wheat bran and gluten meal. The hay was very nearly all Timothy, a slight mixture of other grasses being present.

Analytical data.

Composition of Timothy Hay.

	Air dry hay.						Water-free substance.				
	Water.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
CXL. Timothy Hay	7.63	4.61	6.88	30.15	46.33	4.40	4.99	7.44	32.64	50.17	4.76
CXLI. Timothy Hay	7.63	5.22	6.69	30.34	46.32	3.80	5.65	7.24	32.84	50.16	4.11

Composition of Feces from Timothy Hay.

	Fresh feces.		In 100 parts dry substance.				
	Water.	Dry substance.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
Timothy Hay, CXL, Sheep 1.....	70.10	29.90	9.01	10.53	36.48	41.19	2.79
" 2.....	54.27	45.73	7.85	9.51	37.53	41.95	3.16
" 3.....	64.26	35.74	8.45	9.87	34.42	44.17	3.11
" 4.....	60.43	39.57	8.69	10.25	29.03	49.19	2.84
Timothy Hay, CXLI, Sheep 1.....	63.46	36.54	8.56	9.34	36.19	43.26	2.65
" 2.....	69.00	31.00	8.77	9.95	37.02	41.33	2.93
" 3.....	56.41	43.59	7.93	8.76	36.13	44.03	3.15
" 4.....	47.55	52.45	8.09	9.17	35.29	43.89	3.56

Food Eaten and Feces Excreted.

	Food eaten daily.		Feces excreted daily	
	Air dry.	Water-free.	Fresh.	Water-free.
Timothy Hay, CXL, Sheep 1.....	700	646.6	891.2	266.5
" 2.....	700	646.6	620.	283.5
" 3.....	700	646.6	680.	243.0
" 4.....	700	646.6	700.	277.
Timothy Hay, CXLI, Sheep 1.....	700	646.6	752.	274.8
" 2.....	700	646.6	861.	266.9
" 3.....	700	646.6	614.	267.7
" 4.....	647	594.6	438.	229.7

Digestibility of Timothy Hay.

	Dry matter.	Organic substance.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
Timothy Hay, CXL, Sheep 1.....	58.7	60.5	25.7	41.9	53.9	66.1	75.9
" 2.....	56.1	57.4	30.9	44.0	49.6	63.3	71.1
" 3.....	62.4	63.7	36.5	49.8	60.3	66.9	75.6
" 4.....	57.1	58.8	25.4	40.9	61.9	58.0	74.6
Average.....	**58.5**	**60.1**	**29.6**	**44.1**	**56.4**	**63.6**	**74.3**
Timothy Hay, CXLI, Sheep 1.....	57.5	58.8	35.6	45.3	53.1	63.3	72.5
" 2.....	58.7	60.0	35.9	43.3	53.5	65.9	70.7
" 3.....	58.6	59.6	41.9	49.8	54.5	63.7	69.2
" 4.....	61.3	62.3	45.6	51.9	58.3	66.	67.0
Average.....	**59.1**	**60.2**	**39.7**	**47.5**	**54.8**	**64.7**	**69.8**

Digestibility of Various Roots.

Date of the experiment, January, 1891.

Animals used, Sheep.

Daily ration, { 500 grams Timothy Hay (CXL).
2000 grams Roots.

Total period, 12 days.

Feces collected, last five days.

The digestibility of roots with ruminants cannot be determined by feeding a ration composed of them alone. It is necessary, therefore, to feed with them some fodder material like hay, straw, etc. The roots, the digestion coefficients of which have been ascertained by feeding trials during 1890 and 1891, are sugar beets, mangolds, rutabagas and English flat turnips. With these were fed a known quantity of Timothy hay (No. CXL), the digestibility of which had been previously determined. In order to test the four varieties of roots mentioned, it was necessary to employ four animals during two periods.

Analytical Data.

Composition of the Roots.

	Water.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
CXXXIII, Sugar Beets.	83.75	1.11	1.56	.87	12.57	.14	6.85	9.60	5.37	77.31	.87
CXXXII, Mangolds....	88.27	1.11	1.24	.73	8.53	.12	9.49	10.56	6.20	72.64	1.01
CXXX, Rutabagas.....	89.05	.72	.89	1.00	7.80	.54	6.58	8.13	9.06	71.29	4.94
CXXXI, Eng. Flat Turnips.....	90.24	.92	1.10	1.02	6.32	.40	9.43	11.28	10.43	64.77	4.09

Composition of Feces from Roots.

	Fresh feces.		In 100 parts water-free substance.				
	Water.	Dry substance.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free substance.	Fat.
Sugar Beets, Sheep 1.....	61.09	38.91	13.69	16.59	32.16	40.25	3.31
" 3.....	54.93	45.07	16.22	10.32	30.34	39.65	3.47
Mangolds, Sheep 2.....	58.53	41.47	13.74	10.89	31.13	40.68	3.56
" 4.....	53.17	46.83	15.01	10.14	30.05	41.17	3.63
Rutabagas, Sheep 1.....	50.58	49.42	11.24	10.17	31.94	43.56	3.09
" 3.....	50.99	49.01	12.53	10.50	32.60	40.73	3.64
Eng. Flat Turnips, Sheep 2.....	54.79	45.21	10.87	10.77	32.35	42.61	3.40
" 4.....	79.71	20.29	12.30	10.06	30.84	43.67	3.13

FOOD EATEN AND FECES EXCRETED.

	Food eaten daily.		Feces excreted daily.	
	Air-dry and green.	Water-free.	Fresh.	Water-free.
Sheep 1, { Timothy Hay (CXL).....	500	461.8 }	540.8	210.4
{ Sugar Beets.....	2000	325. }		
Sheep 3, " " "	"	"	463.2	208.8
Sheep 2, { Timothy Hay (CXL).....	500	461.8 }	591.8	245.4
{ Mangolds	2000	234.6 }		
Sheep 4, " " "	"	"	509.2	238.5
Sheep 1, { Timothy Hay (CXL).....	500	461.8 }	432.	213.5
{ Ruta Bagas	2000	219. }		
Sheep 3, " " "	"	"	460.	225.5
Sheep 2, { Timothy Hay (CXL).....	500	461.8 }	464.	209.8
{ Eng. Flat Turnips.....	2000	195.2 }		
Sheep 4, " " "	"	"	994.	201.6

DIGESTION COEFFICIENTS OF VARIOUS ROOTS.

	Dry substance.	Organic matter.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
Sugar Beets, Sheep 1.....	94.2	97.6	43.2	90.	88.5	99.8	53.5
" 3.....	94.8	99.9	20.7	92.6	113.	100.	46.4
Average.....	**94.5**	**98.7**	**31.9**	**91.3**	**100.7**	**99.9**	**49.9**
Mangolds, Sheep 2.....	77.1	82.7	21 1	69.7	26.8	90.8	.....
" 4	80.	87.	11.7	79.8	58.8	91.9	.....
Average	**78.5**	**84.8**	**16.4**	**74 7**	**42.8**	**91.3**	.....
Rutabagas, Sheep 1.....	90.	93.	45.8	85.9	87.5	94.4	91.6
" 3.....	84.5	89.2	16.7	74.7	61.	95.1	76.8
Average.....	**87 2**	**91.1**	**31.2**	**80 3**	**74.2**	**94.7**	**84.2**
Eng. Flat Turnips, Sheep 2.....	90.7	93.2	64.1	84 5	89.2	96.	82.5
" 4.....	94 9	99.	53.2	95.	117.	97.	92.5
Average.....	**92.8**	**96.1**	**58.6**	**89.7**	**103.**	**96.5**	**97.5**

DIGESTIBILITY OF GLUTEN MEAL AND WHEAT BRAN.

Time of experiment, February, 1891.

Animals used, Sheep.

Daily ration, { 500 grams Timothy hay,
{ 300 grams grain.

Total period, 12 days.

Feces collected, last five days.

There were two reasons for making digestion experiments with these two commercial cattle foods, viz: No attempt appears to have been made to learn the digestibility of gluten meal, and a former trial gave such unfavorable and somewhat unexpected

results with wheat bran that it was thought best to carry through another experiment to test the correctness of the previous figures. In fact roller bran differs to such an extent from that with which German trials were probably made, that the single previous test by this Station is really the only one to which reference could heretofore be had that applies to such bran as the market now affords.

The gluten meal and bran were purchased in the Bangor market.

Analytical data.

Composition of Gluten Meal and Wheat Bran.

	Air dry material.						In 100 parts water-free material.				
	Water.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
CXXXIV, Gluten Meal	10.20	1.00	30.81	.98	47.22	9.79	1.11	34.30	1.09	52.60	10.90
CXXXV, Wheat Bran	11.73	6.00	15.50	9.66	52.01	5.10	6.79	17.56	10.94	58.93	5.78

Composition of Feces from Gluten Meal and Wheat Bran.

	Fresh feces.		In 100 parts water-free substance.				
	Water.	Dry substance.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
Gluten Meal, Sheep 2	63.82	36.18	8.91	11.57	32.36	42.81	4.35
" " " 4	77.90	22.10	9.65	16.36	27.80	41.98	4.21
Wheat Bran, Sheep 1	62.89	37.11	10.65	9.15	29.94	45.98	4.28
" " " 3	70.42	29.58	11.72	8.46	29.11	47.27	3.44

Food Eaten and Feces Excreted.

		Food eaten daily.		Feces excreted daily.	
		Air dry.	Water-free.	Fresh.	Water-free.
Sheep 2,	Timothy Hay	500	461.8	636.4	230.2
	Gluten Meal	300	269.4		
Sheep 4,	Timothy Hay	500	413.5	884.	195.4
	Gluten Meal	300	269.4		
Sheep 1,	Timothy Hay	500	461.8	756.4	280.7
	Wheat Bran	300	264.8		
Sheep 3,	" "	"	"	1046.8	309.6

Digestion Coefficients for Gluten Meal and Wheat Bran.

	Dry substance.	Organic matter.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
Gluten Meal, Sheep 2	84.7	86.3	.....	90.2	.....	88.2	85.6
" " " 4	90.2	91.9	.....	83.	33.4	93.5	90.1
Average	**87.4**	**89.1**	.....	**86.6**	.....	**90.8**	**87.8**
Wheat Bran, Sheep 1	65.3	68.5	.....	82.7	46.9	69.6	59.5
" " " 3	54.4	59.5	.....	81.5	25.5	58.6	68.6
Average	**59.8**	**64.**	.....	**82.1**	**36.2**	**64.1**	**64.**
Results of previous trial*	58.8	62.8	.....	73.7	.....	67.5	82.6

* See Rep. Me. Exp. Station, 1889, p. 61.

Summary of Digestion Coefficients.

	Dry substance.	Organic matter.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
Hungarian Grass	63.4	65.6	35.5	62.4	67.8	65.8	52.3
Hungarian Hay	65.	66.3	47.4	60.	67.6	67.1	63.8
So. Corn Fodder	69.4	70.6	57.4	65.4	74.2	69.5	70.9
Field Corn Fodder	70.6	72.4	52.9	61.8	75.6	72.6	70.2
Sweet Corn Fodder	69.7	73.5	39.4	61.8	76.7	72.1	76.4
Timothy Hay	58.5	60.1	29.6	44.1	56.4	63.6	74.3
Timothy Hay	59.1	60.2	39.7	47.5	54.8	64.7	69.8
Sugar Beets	94.5	98.7	31.9	91.3	100.7	99.9	49.9
Mangolds	78.5	84.8	16.4	74.7	42.8	91.3	.....
Rutabagas	87.2	91.1	31.2	80.3	74.2	94.7	84.2
Eng. Flat Turnips	92.8	96.1	58.6	89.7	103.	96.5	97.5
Gluten Meal	87.4	89.1	.....	86.6	.....	90.8	87.8
Wheat Bran	59.8	64.	.....	82.1	36.2	64.1	64.

(1) The Hungarian Grass, both when fed green and after drying, proved to be more digestible than the average of other grasses—notably more so than Timothy.

(2.) The drying of the Hungarian Grass into hay did not diminish its digestibility. This is in accordance with all former experience.

(3.) The corn plant as cut for the silo is one of the most digestible of fodder plants, rating in these experiments as compared with Timothy as 100 : 120. Sixty per cent. of the dry organic matter of Timothy was digested, while with the various corn fodders the average was seventy-two per cent.

The experiments of this year disclose no especial differences in the digestibility of the Southern, Field and Sweet Corn fodders.

(4.) The digestion trials with roots show them to be the most digestible of any of the foods tested, the amount of waste material being very small, averaging not over 8 per cent. of the whole.

(5.) The Gluten Meal, which is a waste product in the manufacture of glucose from corn, was digested to the extent of 89 per cent. of its dry organic matter, which does not differ at all from the figures given in the German tables for the entire grain. The treatment which the grain receives in converting the starch into glucose does not seem to affect the digestibility of the refuse.

(6.) The second trial of the digestibility of American wheat bran gives average figures almost similar to those obtained in the first trial, and shows this cattle food to be but slightly if any more digestible than good hay, and much inferior in this respect to grains such as maize, oats, barley, etc.

THE PRODUCTION OF FOOD MATERIAL BY VARIOUS FODDER AND ROOT CROPS.

The list of cattle foods which many successful dairymen seem to regard as necessary for winter production of milk includes some green material. This material is furnished either from the silo or by some one of the various root crops, undoubtedly more largely from the former than from the latter at the present time. Ensilage is made almost wholly, at least in this State, from the corn plant, and in regard to the most desirable variety of corn for this purpose there seems to exist quite a difference of opinion. The roots most generally grown for winter feeding are mangolds, sugar beets, rutabagas and English field turnips. The inquiry of the farmer is, which of these crops is the most profitable? "Shall I produce the large varieties of Dent corn, such as the Virginia White Horse Tooth, or shall I depend upon the varieties of Flint corn and Sweet corn which make much smaller growth, but which come more nearly to maturity in this climate? Or is it better to adhere to the former practice and produce sufficient roots of some kind to furnish the needed change of food?" In attempting to study this question, in order to give the farmer helpful information, we must first decide what is the proper standard for judging the profitableness of a crop. Two factors must be considered, (1) the amount of food material produced and (2) its cost. With the latter factor the Experiment Station does not propose to deal in this connection. In regard to the former factor, we must ask, How shall we judge with regard to the production of food material? It is very evident that we cannot take as our standard the total weight of the crop, for the reason that there is so large variation of the amount of water in the various crops which have been mentioned. This water is worth no more than that which the animal takes from the trough. But shall we use the total dry matter as a measure of profitable production, excluding the question of cost? This would certainly be more accurate than to judge from the total weight of the crop, but it is evident that there would still be an inaccuracy from the fact that the dry matter of the various fodder plants varies greatly in digestibility. We must conclude then that the proper standard by means of which to compare the production of food material by various crops

is the amount of digestible dry material. One other factor enters which it is necessary to consider to some extent, and that is the relative value of equal amounts of digestible material from different crops. For instance, the large varieties of Dent corn do not mature in this climate, but must usually be cut and put in the silo before the formation of the ear, while with our early varieties of field and sweet corn, the plant can generally be fully matured. The question arises, Is a pound of digestible material in the immature large variety equal in value to a pound of digestible material from the smaller and maturer sort?

The Maine Experiment Station has addressed itself to the study of the problems suggested above. Work in this direction was begun in the summer of 1888 and has been continued through three seasons.

In 1889 the experiment was confined to three varieties of the corn plant (see Rep. Me. Exp't Station 1889, p. 46), but in 1890 and 1891 root crops and other varieties of fodder crops were included.

The general plan followed has been to select soil uniform in quality and in previous treatment, producing upon it equal areas of the several crops under like conditions of manuring, cultivation, etc. A record has been made of the weight of each crop, and its composition, and in part its digestibility, have been determined. The following is a description of the soil and of the method of manuring, planting and cultivation for the several seasons:

1888.—Soil, clayey loam. Land in grass for several years previous. Sod broken in spring, and 600 lbs. superphosphate drilled in with seed. Seed drilled in with Eclipse corn planter. Three varieties of corn were planted on two acres. This area was divided into twelve plots, four plots being used for each variety.

1890.—Soil, clayey loam. In cultivation for four previous years. About seven cords per acre of good manure from barn cellar applied the previous autumn. Seed planted by hand. Size of plots one-twentieth of an acre, two plots being devoted to each variety of crop. The corn and root crops were thinned during cultivation to a uniform distance of plants.

1891.—Soil, clayey loam. Land in grass since 1885. Sod broken in spring and about six cords of manure from cow stable applied per acre. 240 lbs. per acre of a fertilizer consisting

of 100 lbs. dissolved bone black, 100 lbs. nitrate of soda and 40 lbs. muriate of potash were sowed in the drill before the seed was planted. Manner of seeding and cultivation the same as in 1890.

The varieties of corn, roots, etc., which have been grown are the following:

Southern Corn,—White Horse Tooth.
Field Corn,—a Flint variety maturing in Penobscot Co.
Sweet Corn,—Early Crosby.
Sugar Beets,—Lane's Imperial.
Mangolds,—Champion Yellow Globe.
Rutabagas,—Yellow Globe.
English Flat Turnip,—Purple Top Strap Leaf.
Peas,—Black Eyed Marrowfat.
Hungarian Grass.

The Hungarian grass was not grown on the same land as the other crops, but the yield of this fodder plant was determined by weighing the produce from a crop fed to the College herd.

In 1888 the corn was planted with a seed drill as before stated, and when hoed the first time it was thinned as nearly as possible to two stalks per foot. About the same number of stalks were grown with each variety. In both 1890 and 1891 two stalks were grown to a foot with the Southern Corn and one stalk to a foot with the Common Field Corn and Sweet Corn. This degree of thickness with the several varieties was adopted because of the results of an investigation made by the Connecticut Experiment Station in the summer of 1888. (See Report of Conn. Exp't Station, 1889, Part 1, pages 9 to 43.) This investigation showed that the maximum amount of dry matter was produced when the variety of Dent corn used was grown with two stalks to the foot and the Flint variety with one stalk to the foot. Of course the conditions of growth are different in Connecticut from what they are in Maine, and it is possible that a similar investigation made at this Station would show that a different thickness of planting should be adopted in order to obtain maximum production. No better guide is at hand, however, than the outcome of the experiment mentioned.

In the case of the root crops the plants were thinned to the distance of one foot in a row in all of the three seasons. The peas were sown in drills at the rate of two bushels of seed per acre. With all of the crops the distance between the rows has been three feet.

The three varieties of corn were cut and weighed at the time the kernels of common field corn had become glazed and the sweet corn was past the canning stage. No ears had formed on the Southern corn. The roots were left in the ground as long as possible.

PRODUCTION BY SEVERAL VARIETIES OF FODDER AND ROOT CROPS.

	Total crop as harvested, per acre.	Per cent. dry matter in grain crop.	Yield of dry matter per acre.	Per cent. of dry matter digestible.	Yield of digestible dry matter per acre.
	lbs.	%	lbs.	%	lbs.
Southern Corn, 1888	26.295	12.30	3234.3	65.	2102.3
Southern Corn, 1890	32.950	14.94	4922.7	69.	3396.7
Southern Corn, 1891	46.340	13.46	6237.4	69.*	4303.8
Southern Corn, Average for all	35.195	13.57	4798.1	.....	3267.4
Southern Corn, Average for 1890 & 1891	39.645	.....	5580.	.....	3850.
Field Corn. (Flint) 1888	14.212	17.4	2472.9	70.	1720.5
Field Corn. (Flint) 1890	15.300	15.84	2415.9	71.	1715.3
Field Corn. (Flint) 1891	28.080	13.55	3804.8	71.*	2701.4
Field Corn. (Flint) Average for all	19.197	15.60	2892.8	.....	2045.7
Field Corn. (Flint) Average for 1890 & 1891	21.690	.....	3110.	.....	2208.
Sweet Corn 1888	14.205	13.5	1917.6	61.	1169.7
Sweet Corn 1890	13.300	16.15	2147.9	70.	1503.5
Sweet Corn 1891	23.220	13.76	3195.0	70.*	2236.5
Sweet Corn Average for all	16.908	14.47	2420.1	.....	1636.5
Sweet Corn Average for 1890 & 1891	18.260	.....	2671.	.....	1870.
Mangolds 1890	18.400	11.73	2158.3	78.5	1694.3
Mangolds 1891	12.350	8.65	1068.	78.5*	838.4
Mangolds Average	15.375	10.19	1613.1	.....	1266.
Sugar Beets 1890	14.350	16.25	2331.9	94.5	2203.6
Sugar Beets 1891	20.940	13.60	2847.8	94.5*	2691.2
Sugar Beets Average	17.645	14.92	2589.9	.....	2447.4
Rutabagas 1890	31.550	10.95	3454.7	87.2	3012.5
Rutabagas 1891	31.840	10.60	3375.	87.2*	2943.0
Rutabagas Average	31.695	10.77	3414.8	.....	2977.7
Eng. Flat Turnips 1890	32.350	9.76	3157.4	92.8	2930.
Eng. Flat Turnips 1891	24.650	7.96	1962.1	92.8*	1820.7
Eng. Flat Turnips Average	28.500	8.86	2559.7	.....	2375.
Hungarian Grass, 1890	18.940	24.71	4680.	63.4	2967.
Peas, (total crop) 1890	3.522	.....	.....	.....	.....
Peas, (total crop) 1891	5.329	.....	.....	.....	.....
Peas, (total crop) Average	4.425.5	.....	.....	.....	.....
Peas, (grain) 1890	1.850	85.00	1572.	87.	1367.6
Peas, (grain) 1891	1.481	.....	1258.8	87.	1095.1
Peas, (grain) Average	1.665.5	.....	1415.4	.....	1231.3
Timothy Hay (assumed crop)	4.000	87.50	3500.0	.....	.....

* Assumed to have the same digestibility as crops of previous year.

SUMMARY OF AVERAGE RESULTS FOR 1890 AND 1891.

	Yield per acre of crop as harvested.	Yield per acre of dry matter.	Yield per acre of digestible dry matter.
	lbs.	lbs.	lbs.
Southern Corn	39,645	5580	3850
Rutabagas	31,695	3415	2978
Hungarian Grass	18,940	4680	2967
Sugar Beets	17,645	2590	2447
English Flat Turnips	28,500	2559	2375
Field Corn (Flint)	21,690	3110	2208
Sweet Corn	18,260	2671	1870
Mangolds	15,375	1613	1266
Peas (Grain)	1,665	1415	1231
Timothy Hay (assumed crop)	4,000	3500	2065

In discussing the above figures which are a statement of the yield of the several crops under consideration, it should be remembered that no effort was made to secure phenomenally large production. It is not claimed that in any case a maximum crop was harvested, although the growth in 1891 of twenty-three tons of So. Corn and fourteen tons of Field Corn per acre, is a fairly creditable showing. The sole purpose of these experiments has been to test the *relative* growth of these fodder and root plants, under conditions as entirely similar as it was possible to make them.

The results here given are not considered as final. Plans are in progress for repeating this work in other sections of the State on typical corn land, under conditions unquestionably favorable to a solution of the problem involved. Notwithstanding the fact that this should be considered as a report of progress, it may not be out of place to summarize the results so far reached. It should be borne in mind in this connection, that the question of cost is entirely ignored.

(1.) The large variety of fodder corn, namely: the Southern White Horse Tooth, under the conditions in which the crops were grown greatly excelled the other varieties of corn and the roots in the production of total and of digestible dry matter.

(2.) The crops which rank next in the production of digestible dry matter are Hungarian grass and rutabaga turnips.

Special attention is called to the very favorable comparative showing of Hungarian Grass as a fodder producing crop.

(3.) The common impression seems to be that our varieties of field corn and sweet corn which mature in this latitude and which are harvested for the silo after the plants have reached maturity or nearly so, contain much less water and more dry matter than the larger varieties of Southern corn. While these experiments show a difference in the percentage of dry matter in favor of the Field Corn and Sweet Corn, the difference has not proved to be as great as many would expect. The average results for three years show that the Northern field corn contained only two pounds of dry matter per hundred more than the Southern corn at the time the crops were harvested.

(4.) These experiments illustrate very fully the already familiar fact that the weight of a green fodder crop is not a correct standard for judging its value. For instance, 18,940 pounds of Hungarian grass contained more than a third more dry matter than 31,695 pounds of rutabaga turnips, and practically as much dry matter as 32,000 pounds of Southern corn.

TURNIPS AS FOOD FOR SHEEP.

The relative value of different cattle foods is a matter which is very much discussed by farmers. Perhaps no foods have received more attention during the last few years than have those which are fed in a green condition such as ensilage and roots. The Experiment Station receives very many inquiries in regard to their value as compared with hay and the various grains.

Whenever these inquiries have been answered by the writer, the amount of digestible organic matter has been taken as a basis for comparison. For instance, a food containing 60 per cent. of digestible organic matter has been regarded as having five times the capacity for nourishing an animal that one has containing twelve per cent., especially if the two foods are not greatly unlike in the composition of their dry matter. Experiments made by this Station go to show that the digestible matter present in food is a fairly safe standard for measuring its value. A feeding experiment which was made in the winter and spring of 1889, the purpose of which was to compare ensilage and hay, gave results which seemed to warrant the following as part of the conclusions reached. "The experiment furnished still further evidence that the amount of digestible matter present may be regarded as a safe basis for comparing the feeding value of foods of the same class." (Report Maine Experiment Station, 1889, page 75.) The comparison referred to above was made by feeding young steers. In the previous spring of 1888, a similar comparison was made, using milch cows as the experimental animals. This test showed unmistakably that a pound of digestible material coming from a mixture of hay and ensilage gave better results than a pound coming from hay alone, but the difference was not great. In summarizing this latter experiment the following statement was made: "Nevertheless, the testimony of such results as this experiment furnished sustains rather than destroys the general practical utility of the rule in making rations, that fodders have a relative value that is proportionate to their digestible material." (Report Maine Experiment Station, 1889, page 69.)

The results of a few feeding trials like these do not seem to be considered by many to be a sufficient guide for directing their

practice in cattle feeding. Experience and observation have appeared to show that roots have a value which scientific investigation does not accord to them and many feeders are very slow to look any farther than commonly expressed opinion. The opinion is met in many quarters that roots are especially profitable as food for sheep. Hon. I. C. Libby of Burnham, Me., in a conversation with a member of the Station staff, advanced the idea that turnips have a value as sheep food greater than that with which they are generally credited, and greater, perhaps, than they have as food for certain other classes of animals. Later, in a letter addressed to the Director of the Station in response to certain inquiries, Mr. Libby referred to the importance of sheep husbandry to Maine, and expressed the opinion that roots should be made to fill a more prominent place in the sheep ration. He also suggested that the relative value of roots would be a proper subject of investigation by the Station. In accordance with this suggestion, plans were made for conducting an experiment with sheep in the winter of 1890-91, which should have for its sole object a comparison of the value of roots and of mixed grains as fattening food. During the summer of 1890, the requisite quantity of Rutabagas was produced on the College Farm, which were stored in fine condition. Early in December twenty-four good sized and perfectly healthy ewes were purchased. They were somewhat thin in flesh and were in first-rate condition for use in an experiment of this kind.

In planning this experiment it was possible to do so from either of two points of view. It is very commonly remarked when roots are made a subject of discussion, that they are especially valuable because by feeding them the animal is kept in a more healthy condition and his appetite is stimulated, so that more of other kinds of food are consumed and therefore greater growth is obtained than would otherwise be possible. This is one point of view. The other is a consideration of roots as a main supply of food outside the coarse fodder, or as a substitute for grain. Now if an experiment were to be planned to test the value of turnips because of their physiological effect in the ration, the question would be answered only by feeding one lot of sheep on dry food entirely and another lot on dry food combined with more or less roots. But if the nutritive effect of turnips as a main supplement of hay is the point to be considered, then a safe conclusion can more surely be reached by feeding some turnips to one lot of sheep and more to the other, the difference in amount of digesti-

ble material in the two cases to be made up by a larger amount of grain. In this way both lots of sheep would receive the beneficial effect upon health and appetite which green food is supposed to give, and we would be studying the single question of the relative value of roots and grain. Consequently the ration of the two lots of sheep were planned as nearly as possible so that each lot received the same amount of digestible material, the difference being that more of this material came from grain in the one case and more from turnips in the other. The feeding of the sheep was begun on December 23. The rations were as follows:

Lot 1, { 20 lbs. Hay, mostly Timothy.
12 lbs. Mixed Grain.
20 lbs. Cut Rutabagas.

Lot 2, { 20 lbs. Hay.
7 lbs. Mixed Grain.
50 lbs. Rutabagas.

The mixed grain consisted of three parts gluten meal, two parts corn meal and one part wheat bran, by weight. This feeding period was continued until Jan. 30. It is seen that in this period Lot 1 ate five pounds more of the mixed grain each day than Lot 2, and that Lot 2 ate 30 pounds more of turnips daily than Lot 1, or in other words, five pounds of mixed grain were against 30 pounds of turnips, it being calculated that the amount of digestible material would be about the same in the two. The animals were weighed first on December 29th and 30th, and again on Jan. 29th, and 30th. The following table shows the amount of food eaten and the gain of each lot of sheep.

FOOD AND GAIN OF SHEEP IN PERIOD 1.

	Lot 1. More grain.	Lot 2. More Turnips.
No. of days fed	31	31
Weight of hay fed	620 lbs.	620 lbs.
Weight of mixed grain eaten	372 "	217 "
Weight of rutabagas eaten	620 "	1550 "
Weight of sheep at end of period	1222 "	1124 "
Weight of sheep at beginning of period	1125 "	1052 "
Gain in weight	97 lbs.	72 lbs.

It appears by the above that Lot 1, receiving the more grain, gained 97 pounds, and Lot 2, receiving the more turnips, gained 71 pounds, a difference of 25 pounds. It is fair to conclude, then, that the five pounds of grain produced more increase in weight than the

30 pounds of turnips. How about the amount of digestible material in each case? At the time the experiment was begun, the amount of dry matter in the turnips was not actually known, but was assumed from previous analyses. During the time of the first feeding period the percentage of dry matter actually present in the turnips that were being fed was ascertained and it was found that the five pounds of mixed grain contained about four-tenths of a pound more of digestible material than the 30 pounds of turnips. The ration for the second period of feeding, beginning on Jan. 30, was changed therefore somewhat from that of the first period. The changed rations were as follows:

Lot 1. { 20 lbs. Hay.
9 lbs. Mixed Grain.
50 lbs. Rutabagas.

Lot 2. { 20 lbs. Hay.
13 lbs. Mixed Grain.
20 lbs. Rutabagas.

In this period 30 pounds of turnips were offset by only 4 pounds of grain. Lot 1 was fed the larger amount of turnips instead of Lot 2 as in Period 1. The feeding was continued until March 3, the animals being again weighed on each of the last two days.

Below can be seen the weight of the two lots and the amount of gain of each during the second period.

Food and Gain of Sheep in Period 2.

	Lot 1. More Turnips.	Lot 2. More Grain.
No. of days fed	32	32
Weight of hay fed	640 lbs.	640 lbs.
Weight of mixed grain eaten	288 "	416 "
Weight of rutabagas eaten	1600 "	640 "
Weight of sheep at end of period	1346 lbs.	1262 lbs.
Weight of sheep at beginning of period	1222 "	1124 "
Gain in weight	124 lbs.	138 lbs.

Gain of both lots of sheep eating more turnips ..... 235 lbs.
" " " " " " grain ..... 196 "

Difference in favor of ration containing more grain ..... 39 lbs.

The results of the second feeding period still show an advantage with the sheep eating the more grain as compared with the sheep eating the more roots, although rather more digestible material was fed to the latter lot.

AMOUNT OF DIGESTIBLE MATERIAL* IN 100 LBS. OF FOODS EATEN.

	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Timothy hay	2.95	15.75	28.09	2 69
Rutabagas**	1.23	.90	8.30	.70
Gluten meal	26.67	.....	42.97	8.61
Corn meal	8.16	.....	64.30	4.33
Wheat bran	12.76	3.50	33.28	3.26

POUNDS OF DIGESTIBLE MATERIAL EATEN IN 63 DAYS.

	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Larger grain ration for 12 sheep.				
Timothy hay, 1260 lbs	37.2	198.4	353 9	33.9
Rutabagas, 1260 lbs	15.5	11.3	104.6	6.3
Mixed grain, 788 lbs	143 3	4.7	381.9	49.5
Nutritive ratio, 1:6.5	196.0	214.4	840.4	89.7
Larger turnip ration for 12 sheep.				
Timothy hay, 1260 lbs	37.2	198.4	353.9	33 9
Rutabagas, 3150 lbs	38.7	28.3	261.4	15.8
Mixed grain, 505 lbs	91.8	3.	244 7	31.7
Nutritive ratio, 1:7.7	167.7	229.7	860.0	81.4

The results of the entire experiment, covering 63 days of feeding, may be summarized as follows:

One-half of the sheep ate during this time 1340 pounds of digestible material and the other half ate 1338 pounds. The difference between the two rations was simply this: that one-half of the sheep received more of their food from roots than did the other half, the total amount of digestible material being practically the same in the two cases. One-half of the sheep ate 1260 pounds of roots and the other half ate 3150, the difference in the amount of dry digestible organic material

* The figures in this table are obtained from the composition and digestibility of Timothy hays Nos. CXL and CXLI, gluten meal CXXXIV, and wheat bran CXXXV, as found on previous pages of this report. The hay was estimated to have 12.5% of water as fed in the barn. For the corn meal the figures of the general fodder tables were used.

** These turnips contained—water 87.19%, solids 12.81%, protein 1.54%, fiber 1.21%, N-f-ext. 8.74%, fat .59%.

in the two quantities being 206 pounds. This 206 pounds of nutrients from the roots was offset by 208 pounds of nutrients from grain, a practically eduivalent quantity. Notwithstanding this equivalence in the quantity of material in the two rations, the twelve sheep receiving the more grain gained during the 63 days 39 pounds more than did the other twelve. There seems to be no reason why this test is not a fair one and it furnishes a weighty bit of evidence against the somewhat common opinion that the dry matter of roots has an especial and peculiar value beyond the small quantity which it may be wise to feed for the purpose of giving variety to the ration.

There still remains to be considered the reason why the two rations produced unlike results, even though they contained equivalent quantities of digestible material. We find by examination of the figures last given that one ration furnished to the animals considerable more digestible protein (nitrogenous compounds) than did the other, and this fact seems to be the most reasonable explanation of the difference in effect. The more nitrogenous ration produced more increase in weight. This was the ration having more grain and less rutabagas. This result is not surprising when we remember that the food of a pregnant ewe must supply material for the growth of the wool and of the fœtus, and that in both these directions the demand is very largely for protein compounds.

AN EXPERIMENT IN PRODUCING GROWTH IN LAMBS.

The object of this experiment was to present an object lesson on the profits of the liberal feeding of lambs that are intended for the market. A farmer is occasionally found who has adopted the practice of producing early lambs, which by liberal feeding can be put upon an early market at high prices. The more common practice is the production of late lambs which are grown largely on grass and are sold at the lowest prices that rule during the year. It was thought that possibly an illustration of the difference between these two methods might serve to stimulate some towards adopting the former and more profitable practice. It was found that the 24 ewes used in the feeding experiment with roots just described, were likely to drop their lambs during the month of April. As they were a lot of sheep quite uniform in quality, of more than average size and in good condition, because of the liberal rations which they had received, it was decided to use their lambs for this experiment. Accordingly, as fast as the lambs were born, they were divided into two lots. Fortunately there were an even number of pairs of twins, so that when the division into the two lots was completed, it was found that there were ten sheep with twelve lambs in each pen.

These two lots of sheep and lambs were fed in a radically different manner. The ration of Lot 1 was intended to be an intensive ration, or a copy of the method that is used for forcing the growth of early lambs. On the other hand, Lot 2 was fed in a manner similar to that which is adopted by many farmers, who consider the sheep to be an animal that can be successfully fed on the refuse of a barn without the addition of very much grain. The sheep of Lot 1 received what good hay they would consume and a pound of grain each, per day. Besides this, the pen was so arranged that the lambs had access at all times to a supply of mixed grain. The sheep of Lot 2 were fed one-half pound grain per head daily, with what good hay they would eat. The lambs of this lot were allowed no grain excepting what they ate from the mother's ration. Until May 26th, the grain mixture consisted of three parts of gluten meal, two parts of corn meal and one part of wheat bran, by weight. After May 26th, the mixture

was changed to one part of linseed meal, one part of corn meal and one part of wheat bran, by weight. Lot 1 ate 2,990 pounds of hay and 900 pounds of mixed grain. Lot 2 ate 3,010 pounds of hay and 450 pounds of mixed grain. The weight of grain eaten by the lambs of Lot 1 was 534 pounds. Besides this, both lots of sheep received two pounds per day, per head, of rutabaga turnips, until May 19th.

The following table gives the figures in detail for each sheep and lamb of both lots:

RESULTS OF EXPERIMENT IN FEEDING LAMBS.

Lot 1, Liberal feeding.

Date of birth of lambs.	Weight of sheep after birth of lambs.	Weight of lambs at birth.	Weight of fleece of sheep.	Weight of sheep when lamb 3 months old.	Weight of lambs at 3 months.
	lbs.	lbs.	lbs.	lbs.	lbs.
March 21	97	12	5	76	51
" 28	103	8 8 Twins.	6	90	40 45
April 4	108	12	5¼	89	65
" 5	94	9	7	85	44
" 10	110	11	6¾	87	51
" 14	100	9 9 Twins.	8	67	38 38
" 15	95	9	5½	77	45
" 17	68	9	5	60	43
" 21	90	8½	5¾	80	40
" 23	102	10	4½	93	45
Total weights	967	122	58¾	804	545

Lot 2, very moderate feeding.

March 21	90	10	6	71	49
" 29	90	8 8 Twins.	4¾	67	20 20
April 2	107	12	5½	91	34
" 4	102	10	6	94	37
" 6	119	14	7	95	38
" 13	80	10	6½	70	30
" 17	98	8	6½	79	38
" 18	96	11	6	75	32
" 21	93	9	7	50	24
" 23	109	9 9 Twins.	5	76	20 22
Total weights	984	126	60¼	768	364

SUMMARY OF RESULTS.

	Lot 1. Liberal Ration.	Lot 2. Moderate Ration.
	lbs.	lbs.
Total hay fed in 3 months	2990	3010
Total grain eaten by sheep in 3 months	900	450
Total grain eaten by lambs in 3 months	534	.....
Weight of sheep after birth of lambs	967	984
Weight of fleeces taken off	59	60
Weight of sheep when lambs 3 months old	804	768
Loss in weight of sheep after deducting fleece	104	156
Weight of lambs at birth	122	126
Weight of lambs at age of 3 months	545	364
Weight of growth in 3 months	423	238
Average weight of lambs at birth	10.2	10.5
Average weight of lambs at 3 months	45.4	30.3
Largest w't of lambs from any single sheep in 3 mos.	95	49
Largest weight of any single lamb in 3 months	65	49

The second table summarizes the figures of the first. The results of this experiment are quite striking and would have been more so had the sheep been the very best quality of Shropshire grades, for instance. As it is, the object sought of illustrating the profits of high feeding of early lambs is attained. It seems that each lot of sheep lost between one and two hundred pounds in weight during the time the lambs were with them, after deducting the weights of the fleeces, Lot 2 losing 52 pounds more than Lot 1. The twelve lambs of Lot 1 weighed, at the end of three months, 545 pounds, and of Lot 2, 364 pounds, a difference of 181 pounds. As the weights of the lambs when born was, for Lots 1 and 2, 122 and 126 pounds, respectively, the actual growth made after birth was 423 pounds and 238 pounds, or a difference of 185 pounds. Now, to offset this greater loss of weight of 52 pounds on the part of the sheep and greater growth of lambs of 185 pounds, we have the cost of 984 pounds of mixed grain, this being the extra amount which was eaten by the sheep and lambs of Lot 1. We must also take into account the fact that the lambs of Lot 1 were ready for the market during the month of May, when high prices were ruling, while the lambs of Lot 2 must be grown for some time longer in the pasture and be put upon the market at very much lower prices.

A statement of the financial results of an experiment is always a difficult matter. Whatever may be the prices taken to represent the values of any product, these will be found to differ from the prices

which some producers are able to obtain. The best that can be done is to assume as nearly as can be determined, the average market rates according to past experience. In the present instance the case is like this: Two lots of lambs have been grown, one lot being large enough and fat enough to put upon an early market, the other lot being too small and too lean, thus requiring that they should be sent to pasture and sold on a late market. This condition of things corresponds to what may be observed in much of the practice of the State.

Lambs that are dropped in March and which are intended for the market may, by a system of high feeding, be sold at a price which is equal to at least ten cents per pound, live weight. If, however, the kind of feeding is such as still prevails to a very great extent, the lambs will of necessity go to pasture with their mothers and will be sold at a price not exceeding six cents per pound, live weight. Let us, then, apply these prices of ten cents and six cents to the lambs grown in this experiment.*

FINANCIAL RESULTS.

545 lbs. lamb @ 10 cts.	$54 50
364 " " @ 6 cts.	21 84
Difference in value of lambs	$32 66
Value of 52 lbs. sheep @ 5 cts.	2 60
Increased value from liberal feeding	$35 26
Value of 984 lbs. extra grain @ $26	12 79
Net gain from liberal feeding	$22 47
Return per ton for extra grain fed	$71 60

It appears from the above figures that the lot of sheep and lambs which were liberally fed were worth at the end of three months $35.26 more than the other lot. After deducting from this sum the cost of the 984 pounds of grain which were fed over and above that given to Lot 2, we have $22.47 as the net gain which should be credited to liberal feeding.

It seems, therefore, that the extra grain was sold to the sheep at the rate of $71.60 per ton.

* After the above was written the following note was received from Chas. York, Esq., a dealer in groceries and provisions, Bangor: "I find by referring to our books for the past five years that the average price of lambs during May has been 19 cts. per pound, for June 16 cts., and for Aug. and Sept. 8 to 10 cts." This illustrates the condition of the local market merely.

Summary.

(1.) Two lots of sheep, each containing ten sheep and twelve lambs, were fed for three months.

(2.) One lot of sheep ate 3,000 pounds of hay and 1,434 of mixed grain. The other lot ate 3,000 pounds hay and 450 pounds of mixed grain. Lot 1 ate, therefore, 984 pounds more of grain than Lot 2.

(3.) During the three months the sheep of Lot 1 lost 104 pounds in weight, and Lot 2, 156 pounds, a difference in favor of Lot 1, of 52 pounds. The lambs of Lot 1 weighed 545 pounds, and of Lot 2, 364 pounds, a difference in favor of Lot 1 of 181 pounds.

(4.) The value of the lambs in Lot 1 was $54.50, and in Lot 2, $21.84, a difference of $32.66 in favor of liberal feeding, and a net gain above extra cost of grain of $22.47.

(5.) The extra amount of grain fed to Lot 1 was sold to the sheep at the rate of $71.60 per ton.

FEEDING EXPERIMENT WITH COLTS.

An investigation of the relative value of different feeding stuffs as food for colts, involves two main considerations:

(1.) The amount of growth produced.

(2.) The quality of the animal.

A horse is said to have good quality when he has a well developed muscular system and exhibits that nervous activity or force which we call life or spirit. Apart from inherited tendencies, the development of *quality* depends, we may believe, partly upon the kind and quantity of food and partly upon the way the animal is handled, i. e., the exercise and training.

It would be a very difficult task to carry out experiments or investigations that would establish the relation between food and quality. It would be necessary to use more than a few animals, which should be of identical breeding, and which should be fed for several years on the rations to be compared. The writer is not aware that up to the present time such an experiment has been attempted. There exists, however, a very wide spread opinion that oats are superior to any other horse food for giving that muscular and nervous condition which so largely determines the market value of an animal.

A test of the amount of growth produced with colts by various foods is not especially difficult, at least not more so than with bovines. Two such tests have been made by this Station, one in 1890, (see Station Rep't, 1890, p. 68) and one in 1891, the results of which follow. In both instances oats have been compared with a mixture of other grain foods, such as peas and wheat middlings (1890), and gluten meal, linseed meal and middlings (1891).

The outcome of the experiment in 1890 was that oats produced less growth than an equal weight of a mixture of peas and middlings, the relation of growth being as 100 to 111. The fact that in this experiment peas were used as a part of the grain ration, a food that in the market is comparatively costly, seemed to be a good reason for repeating the experiment with commercial foods that are more common, bear a less price and are comparatively nitrogenous in character.

In this second experiment, which was made in the spring of 1891, two colts were used. No. 1 was a grade Percheron filly eleven months old, and No. 2 was a grade Percheron gelding eleven months old.

They were fed through two periods on the following rations:

Period 1, { Colt 1, { 10 lbs. hay. / 6 lbs. grain mixture. } Colt 2, { 10 lbs. hay. / 5 lbs. grain mixture. }

Period 2, { Colt 1, { 10 lbs. hay. / 7 lbs. oats. } Colt 2, { 10 lbs. hay. / 6 lbs. oats. }

The grain mixture consisted of middlings, gluten meal and linseed meal compounded in the ratio of 60, 35 and 15. The average daily cost of the ration in Period 1 was about 12 cents, and in Period 2 about 14 cents, a difference of two cents per day for each animal.

The feeding began on March 12th, and the animals were first weighed on March 17th and 18th. Period 1 continued 43 days, and Period 2, 41 days.

The colts were tied in stalls and were given free exercise in a large yard during all pleasant weather. So far as could be determined, no unfavorable conditions entered into the experiment.

The results are stated below:

	Colt No. 1.	Colt No. 2.
Weight of colts at end of Period 1	776 lbs.	652 lbs.
Weight of colts at beginning of Period 1	711 "	602 "
Gain in weight in 43 days	65 lbs.	50 lbs.
Daily gain on mixed grains	1.51 lbs.	1.16 lbs.
Weight of colts at end of Period 2	794 lbs.	690 lbs.
Weight of colts at beginning of Period 2	776 "	652 "
Gain in weight in 41 days	18 lbs.	38 lbs.
Daily gain on oats	.43 lbs.	.93 lbs.

A glance at the above data is sufficient to show the more rapid growth on the mixed grain ration. Those who carefully consider these figures may be inclined to remark that the difference in growth caused by the two rations is too great and that some disturbing factor must have entered, thus rendering the results invalid. Certainly nothing of the kind was apparent, as before remarked.

In two tests of the relative growth produced in colts by mixed grains and oats, the greater growth was obtained in both instances from the mixed grains.

Let us return to the question of the relation of food to quality. As stated above, there seems to be a widespread opinion that oats are a superior food for horses. During the past few years the claim has been quite generally made, at least in popular literature, that this opinion has been strengthened by the supposed discovery through scientific research of the so-called *avenin*, a compound existing in the oat kernel, and said to possess properties that render it peculiarly stimulating to the nervous system. The existence of such a compound has been accepted as an easy way of explaining the peculiar effect which oats are said to have upon the spirit of a horse and in the development of the wiry, nervous Scotchman, who is addicted to his oat meal.

Has science, as in so many other instances, corroborated a belief reached through common experience? A careful study of the records relating to this question will help us to answer.

It seems that Norton, working in Johnston's laboratory, somewhere in 1845, separated what he evidently regarded as an albuminoid peculiar to the oat grain and it was named by Johnston, avenine. In 1869 Kreusler made an extended study of some of the nitrogenous compounds found in the oat kernel and his work appears to show that Johnston's avenine was very similar to legumine, and he accordingly named it oat legumine. Later, Osborne of the Connecticut Experiment Station, has made a very elaborate study of the various proteids separated from the oat grain by a number of solvents. The methods used by Osborne, owing to an advance in knowledge, were superior to those adopted by previous investigators, but did not tend to confirm the conclusions of either Norton or Kreusler. It appears to be true that notwithstanding the fact that the proteids of the oat grain have been made the subject of several very careful and elaborate investigations, using the best methods available, we have not yet any conclusive evidence that the oat kernel contains any characteristic nitrogenous compounds which may not be found in other grains. It is not difficult to see how the existence of this avenine as a substance peculiar to the oat plant has come to be accepted as a fact in popular literature, because when an error once obtains a foothold it is difficult to dislodge; but it is not so clear why this supposed compound should be credited with being a nerve stimulant. The writer is unable to find any investigation undertaken with a view to testing this matter; in fact is unable to find any data upon which such a conclusion could properly be based.

This seems to be an instance of that strange logic which so often appears in popular literature, namely: oats are a stimulating food; avenine exists in oats; therefore avenine is a stimulant. The writer is not prepared to deny that oats may have peculiar food properties that render them especially valuable as food for horses, but he believes that it should be distinctly understood that so far the only proof of this is a somewhat generally accepted opinion. It is safe to affirm also that this opinion is derived from common observation, rather than from any accurate investigations and it is just possible that it may share the fate of many other popular notions having a similar foundation. It is certainly to be considered that oats are a valuable food for horses if for no other reason because they can be fed very freely without danger of injury to health. Is it not possible that this food attained its present reputation at a time when corn was the particular food with which it was compared, and now that the markets afford such a variety of other foods equally nitrogenous or more so, can we be sure that oats are as essential as they once were to the development of a good piece of horse flesh?

The practical application of this discussion is this: Oats are a comparatively costly feeding stuff, and if they are not essential to the horse ration there would be a financial advantage in discarding their use so long as present prices hold.

THE INFLUENCE OF FOOD UPON THE QUALITY OF BUTTER.

There are many factors which determine the quality of butter, the most prominent of which is the individual character of the animal. Besides this we have the kind and condition of food, surroundings in which the animal is kept and the period of lactation. We know of the influence of these factors only in a general way. The exact relations between breed, food, surroundings and other conditions and the chemical and physical characteristics of butter are but little understood. Still more ignorant are we of the way in which certain causes produce their effects, as for instance, granting that the grade of butter may be changed by varying the food, we scarcely know anything about how this effect is produced. It is a fact that but few careful scientific investigations have been made having for their object a determination of the causes that influence the quality of butter. There has been, however, quite a material advance in recent years in our knowledge of the butter fats and in our methods of determining the physical and chemical properties of butter. This has been brought about to some extent by the study that has been necessary in finding some method of distinguishing between natural and artificial butters, and is an important step towards a better knowledge of the conditions that influence the character of butter.

The study which a butter is given in the laboratory, at the present time, involves principally the following determinations: The specific gravity, the melting point, the percentage of volatile acids and the iodine number or the amount of olein. There are other tests applied which are of less importance, perhaps. All these determinations are of value only in their relation to what we speak of as the table qualities of butter.

The influence of different foods upon butter is a subject in regard to which there are many conflicting opinions. For instance, it has been very strongly asserted by many Maine dairymen that no butter is of so high grade as that which is made when the grain ration consists of corn meal and wheat bran. On the other hand, those who are feeding the oil meals freely assert that the quality of the butter is not in any way injured. One difficulty that is in

the way of an intelligent study of the effect of foods is our ignorance of the source of the butter fats. While the prevailing theory is, perhaps, that the butter fats are produced from the nitrogenous constituents of the food, there are still those who believe, and their opinions cannot be entirely gainsaid, that the fats of the food in some way directly contribute to the fats in the milk. If the fats of the food are conveyed directly into the butter, then we would expect to see a marked effect from the presence of either linseed meal or cotton seed meal in the ration, as these feeding stuffs carry a much higher percentage of fats than do others.

By the recommendation of the Station Council, this matter has been made the subject of an experiment, although similar ones have been conducted before. Five of the Station cows were fed three different kinds of rations during as many periods, the rations in the second period differing very materially from those in the first and third. An attempt was made to have this middle ration carry the smallest amount of vegetable fats that would be found in any combination of ordinary foods, while the first and third rations contained a fair proportion of cotton and linseed meal. The exact quantities and kinds of foods fed during the three periods are as follows:

Period 1—Cotton-seed meal, corn meal and wheat bran.

Period 2—Pea meal and barley meal.

Period 3—Linseed meal, corn meal and wheat bran.

KINDS AND QUANTITIES OF FOOD.

	Hay.	Cotton seed meal.	Linseed meal.	Corn meal.	Wheat bran.	Peas.	Barley.
1ST PERIOD.							
Jansje	23.9	2	.....	4	2	.....	.....
Nancy	22.3	1¾	.....	3½	1¾	.....	.....
Queen Linda	20.6	1¾	.....	3½	1¾	.....	.....
Agnes	20.6	1½	.....	3	1½	.....	.....
Ida	20.2	1½	.....	3	1½	.....	.....
2D PERIOD (Feb. 21 to Mar. 18).							
Jansje	24.	.....	.....	.....	.....	4	4
Nancy	22.7	.....	.....	.....	.....	3½	3½
Queen Linda	21.1	.....	.....	.....	.....	3½	3½
Agnes	20.2	.....	.....	.....	.....	3	3
Ida	20.2	.....	.....	.....	.....	3	3
3D PERIOD.							
Jansje	21.5	.....	2	4	2	.....	.....
Nancy	21.5	.....	1¾	3½	1¾	.....	.....
Queen Linda	20.5	.....	1¾	3½	1¾	.....	.....
Agnes	20.5	.....	1½	3	1½	.....	.....
Ida	20.5	.....	1½	3	1½	.....	.....

Composition of the Foods.

	Water.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fats.
CXLII, Cotton-seed Meal	9.30	6.95	44.62	5.56	23.43	10.14
CXLV, Linseed Meal, O. P.	9.35	5.01	36.19	7.89	33.71	7.85
CXLIII, Pea Meal	15.11	4.17	19.56	5.75	53.49	1.92
CXLIV, Barley	14.42	6.42	9.31	10.54	54.97	4.34

Yield of Milk.

	Jansje.	Nancy.	Queen Linda.	Agnes.	Ida.	Total.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Feb. 8th—14th	126	108	210	136	129	709
" 15th—21st	134	100	212	133	124	703
" 22d—28th	131	100	197	133	127	688
March 1st—7th	125	89	188	115	108	625
" 8th—14th	123	94	183	118	107	625
" 15th—21st	125	99	176	116	114	630
" 22d—28th	125	99	181	125	114	644
" 29th—April 4th	128	96	179	123	110	636
April 5th—11th	119	99	172	125	106	621

Composition of Milk.

	Total solids.	Ash.	Albuminoids.	Sugar.	Fat.
Jansje.					
Feb. 9th—13th, C. S. meal mixture	13.11	.65	3.41	5.33	3.72
March 9th—13th, peas and barley	13.14	.65	3.78	4.77	3.94
April 13th—17th, Linseed meal mixture,	13.04	.65	3.60	5.02	3.77
Nancy.					
Feb. 9th—13th	12.57	.65	3.46	4.67	3.79
March 9th—13th	12.40	.65	3.38	4.89	3.48
April 13th—17th	12.20	.65	3.35	4.61	3.59
Queen Linda.					
Feb. 9th—13th	12.40	.65	3.10	5.12	3.32
March 9th—13th	12.16	.65	2.89	5.34	3.28
April 13th—17th	12.04	.65	2.93	5.21	3.25
Agnes.					
Feb. 9th—13th	14.46	.75	3.90	5.15	4.66
March 9th—13th	14.26	.75	3.94	4.78	4.79
April 13th—17th	13.84	.75	3.79	4.77	4.53
Ida.					
Feb. 9th—13th	14.59	.75	3.80	4.74	5.30
March 9th—13th	14.23	.75	3.72	4.74	5.02
April 13th—17th	14.36	.75	3.85	4.50	5.23

Pounds of Other Solids with Each 100 lbs. of Fat.

	Jansje.	Nancy.	Queen Linda.	Agnes.	Ida.
1st Period	252	272	273	210	175
2d Period	232	256	271	198	183
3d Period	246	240	270	205	174

Pounds of Fat for Each 100 lbs. Albuminoids.

	Jansje.	Nancy.	Queen Linda.	Agnes.	Ida.
1st Period	109	109	107	119	137
2d Period	104	103	114	122	135
3d Period	105	107	111	119	136

Melting Points of Butter.

	Centigrade temperature.			Fahrenheit temperature.		
	Cotton-seed, corn meal and wheat bran.	Peas and barley.	Linseed, corn meal and wheat bran.	Cotton-seed, corn meal and wheat bran.	Peas and barley.	Linseed, corn meal and wheat bran.
	deg.	deg.	deg.	deg.	deg.	deg.
Jansje—Holstein	36.3	33.6	34.2	97.2	92.5	93.6
Nancy—Ayrshire	35.	33.1	32.2	95.	91.6	90.
Queen Linda—Ayrshire	34.	32.1	33.1	93.2	89.8	91.6
Agnes—Jersey	34.2	35.1	33.6	93.6	95.2	92.5
Ida—Jersey	35.	33.9	35.2	95.	93.	95.4

Volatile Acids.

	Cotton-seed, corn meal and wheat bran.	Peas and barley.	Linseed, corn meal and wheat bran.
Jansje—Holstein	28.7	28.7	28.3
Nancy—Ayrshire	32.3	28.9	28.7
Queen Linda—Ayrshire	32.3	30.6	30.4
Agnes—Jersey	28.8	28.2	26.2
Ida—Jersey	30.4	27.7	28.6

Iodine Equivalent.

	Cotton-seed, corn meal and wheat bran.	Peas and barley.	Linseed, corn meal and wheat bran.
Jansje—Holstein	31.5	27.3	32.
Nancy—Ayrshire	32.4	30.5	34.8
Queen Linda—Ayrshire	33.9	28.8	30.2
Agnes—Jersey	28.	23.	30.5
Ida—Jersey	26.1	25.3	25.6

The grain foods of the first period constituted the regular grain rations which the animals had been receiving for more than two years. During the entire time of these periods a record was made of the yield of milk. On five days in each period the milk was analyzed, as was also the skimmed milk from the cold setting process. The five days' cream was churned and the resulting butter was tested for the melting point, the per cent. of volatile acids and the iodine equivalent or per cent. of olein. The facts that are displayed in the preceding tables show:

(1.) Yield of milk.

(2.) Its general composition.

(3) The relation of the fats to the albuminoids and to the other solids.

(4.) The melting point of the butter fats.

(5.) The relative amount of volatile acids.

(6.) The iodine equivalent or amount of olein.

The results reached in this experiment are not striking, neither are they easy to explain. There was a somewhat diminished yield of milk in passing from the first to the second periods, while the composition of the milk remained unchanged or practically so throughout. Not only did the total amount of solids in the milk remain about the same with the different methods of feeding, but the relation in quantity of the various solids did not change greatly, and whatever changes of this kind did occur were evidently not caused by the food.

It was remarked by both the butter maker and by the chemist who handled the butter in the laboratory, that the butter of the second period was softer than that of the first. We would, therefore, expect to find a lower melting point during the second period and this proves to be the case with the exception of one animal. With part of the animals the volatile acids changed somewhat in passing from one period to another, but these changes are evidently entirely without reference to the character of the ration. There is only one test which gives results that are significant, namely: The test for olein. It appears that the iodine equivalent is uniformly less during the second period than during the first and third, and the differences are quite marked. It is difficult to reconcile this fact with the softer appearance of the butter and the lower melting point. When the olein or liquid fat diminishes in quantity we would expect harder butter and a higher melting point.

Evidently the changes which occurred in the composition of the butter are somewhat complex and were not wholly discovered by the tests which were applied.

Summary.

(1.) Five cows, including one Holstein, two Ayrshires and two Jerseys, were fed three different rations during as many periods.

(2.) The grain ration of the first period consisted of a mixture of cotton-seed meal, corn meal and wheat bran; during the second period, of peas and barley, and during the third period of linseed meal, corn meal and wheat bran.

(3.) The amount of milk was diminished somewhat in passing from the first to the second period, and increased slightly after changing to the third period.

(4.) The composition of the milk varied but little and no more, or even less, during the three periods, than is often observed when the ration is not changed.

(5.) The relation in quantity in fats to the other solids varied somewhat, but apparently without reference to the food.

(6.) With four of the cows the melting point of the butter was considerably lower during the second period than during the first.

(7.) The relative amount of volatile acids varied only within quite narrow limits and apparently was not affected by the food.

(8.) With all the cows the percentage of olein (liquid fat) was apparently considerably less during the second period, when the peas and barley were fed, than during the first and third periods.

Even though it is possible to draw only limited conclusions from this experiment, some practical suggestions appear:

(1.) Quite radical changes may be made in the kind of grain ration fed, without affecting the quality of the milk.

(2.) The tendency of butter to melt during hot weather may be influenced by the kind of food, and also the degree of hardness may be affected.

(3.) A mixture of Cotton-seed Meal or Linseed Meal with Corn Meal and Wheat Bran, especially the C. S. Meal mixture, produced butter less easily melted, and of a more solid appearance, than did the Peas and Barley.

Other Observations on the Effect of Food upon Butter.

Ladd, at the New York State Experiment Station (Rep. 1888 p. 291) investigated the effect of introducing Linseed Meal into the ration and found an increase in the iodine number and also in the viscosity. Harrington, at the Texas Experiment Station (Rep. 1889, p. 100), found that a grain ration entirely of Cotton-seed Meal raised the melting point of the butter and also the per centage of volatile acids. He sent samples of the same butter to Prof. Wiley of the U. S. Department of Agriculture, whose examination (see Rep. Dept. Agr. 1889, p. 181) corroborated Harrington's results and showed, moreover, that the iodine number for the Cotton-seed butter was higher than for the other. A second set of samples received by Wiley from Harrington did not show such marked results. Prof. Wiley subsequently made an investigation (loc. cit. p. 184) in co-operation with the Maryland Experiment Station, and he found here that the Cotton-seed caused an elevation of the melting point and a lowering of the percentage of volatile acids. The iodine number, contrary to the previous investigations, was diminished rather than increased by the feeding of Cotton-seed.

An experiment conducted by the New Hampshire Experiment Station (see Bulletin No. 13) indicated that cotton-seed meal increased the hardness of the butter, that gluten meal produced a softer butter than corn meal, ensilage a softer butter than hay, and that there is a more or less definite relation between hardness and the iodine absorption number. The opinion was also expressed that the results showed no definite relation between the melting point and the hardness.

Mayer, a German chemist, has made quite an elaborate investigation (Landw. Vers. Stat. Vol. 35, p. 261) and he reached the following conclusions:

(1.) The amount of volatile fatty acids in butter rises and falls with the rise and fall of the specific gravity.

(2.) The melting point of butter depends more upon the amount of olein in butter than upon the amount of butyrin, capronin, etc. (compounds of the volatile acids), present.

(3.) The content of volatile fatty acids in butter varies for an individual cow within wide limits.

(4.) The content of volatile fatty acids in butter fat is dependent upon the period of lactation (length of time the cow has been milked) and diminishes in general with the advance of the same.

(5.) The content of volatile acids is dependent to a great extent upon the food.

(6.) The melting point is also influenced by the food.

The results which have been reviewed above are to quite an extent discordant and a close study of them may well be an occasion for perplexity. What appears to be true from the results of one investigator does not hold in another case. One fact, however, seems to be quite clearly indicated, which is, that the presence of Cotton-seed Meal in the grain ration gives to the butter a higher melting point, or in other words, increases its resistance to the effects of hot weather. It also seems that when the grain ration consists wholly, or nearly so, of Cotton-seed Meal, the percentage of volatile acids is considerably lowered. What effect this has on the quality of the butter is not as clear. It would not be safe, certainly, with present knowledge, to make very many assertions with regard to the specific effect of this or that food upon the composition and physical characteristics of butter.

MAINE AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 3.

SECOND SERIES.

THE BABCOCK MILK TEST ADAPTED TO TESTING CREAM.

J. M. BARTLETT.

During the past few years several simple and accurate methods for estimating fat in milk, adapted to the use of creameries and cheese factories, have been devised by different chemists. Most of these methods are very useful in testing milk and can be used for testing cream, but none of them seem to be especially adapted to the latter purpose and consequently are of no great value to creameries that collect cream only. The need of some method for determining the value of each patron's cream is now acknowledged by every one that has had much experience with creameries.

Even if the patrons of a creamery all use the cold deep setting process and are careful to keep the water at about 40° at all times, the cream from different animals or herds may vary several per cent.

Fifty samples of cream raised by this process, collected by creameries, were tested at the Conn. Exp't. Station and showed a variation of six per cent. of butter fat. One sample contained 23.8 per cent. another 17.78 per cent.

The temperature at which the milk is kept makes a very great difference in the quality of the cream. If the water in which the cans are submerged is allowed to become warm the cream will be much richer than when it is kept cold. The percentage of fat in cream from the same cows may be increased ten per cent. or more by keeping the water at 70° instead of 40°. Several samples collected by a creamery agent were tested. The lowest yield of fat was 12 per cent. and the highest 30 per cent.

The most of the samples gave from 17 per cent. to 22 per cent.

If this creamery had allowed equal amounts of butter for every inch of cream a great injustice would have been done to some of the patrons.

The writer has for the past few months devoted what limited time could be spared from other station work to studying methods with the idea of especially adopting some one for testing cream. As a result of this investigation the method devised by Dr. Babcock of the Wisconsin Experiment Station was selected, it being more simple and rapid than any that had appeared at the time of beginning this work.

Since that time the Beimling method has been brought out and by some is considered equally good, but the apparatus is a little more expensive. The Babcock method is fully explained in Bulletin No. 24 of Wisconsin Experiment Station, therefore it is only briefly described here. The milk is measured into a test bottle with a graduated neck, and about an equal amount of sulphuric acid is added, which dissolves all solids except the fat. The bottle is then at once whirled in a centrifugal machine to collect the fat on the surface of the liquid. Hot water is then added to raise the fat into the graduated part of the neck of the bottle, where the percentage can be read. The bottle used in the milk test as devised by Dr. Babcock is graduated to estimate no higher than 10 per cent. of fat, and as cream usually contains much more than that. it is evident this bottle cannot be used, if the same quantity (18 grams) is taken for the test.

To take a smaller quantity increases the liability to error and impairs the accuracy of the results. A pipette one third the size used for milk, made to deliver about six grams of cream, was first tried, but so much care was necessary to obtain good results the idea was abandoned. In reading a long column of fat, unless one is expert and very careful to keep the temperature constant, he is liable to make an error of 0.2 or 0.3 per cent., and when only six grams of cream are used the reading must be multiplied by three. which increases the error three-fold. Dr. Babcock recommends using three bottles, dividing the pipette full into three parts. putting one third into each bottle and adding the three readings. This method involves so much work that it would not be pratical in testing a large number of samples. To overcome these difficulties the writer used a bottle like No. 2. graduated to read from 0.2 to 25 per cent. of fat, the bulb on the neck holding 10 per cent. With this bottle cream containing not more than 25 per cent. of fat can be as easily and accurately tested as milk, and as cream raised in deep cans submerged in cold water very seldom contains much over 20 per cent. these bottles are sufficiently large

to answer the purpose of our creameries. Very rich cream containing over 25 per cent. fat may be diluted one half with water, or a 9c. c. pipette can be used and the readings multiplied by 2., but can be more accurately tested with a bottle like No. 3 described later on.

These test bottles can be used just as well for milk, so another set is not necessary. Bottle No. 2 cannot however be used in the regular size centrifugal machine as it is about one and one-half inches longer than the bottles used for milk testing.

A bottle of the same style, graduated to read to 23 per cent. may be used in the regular size machine.

No. 3 represents a bottle designed for testing very rich cream without reducing the quantity used for the test. Such cream, carrying over 30 per cent. fat, is frequently obtained from the separator or from milk kept at a temperature of about 60° or 70°. This bottle as is shown by the diagram is made in two pieces and is graduated to read to 35 per cent. It has some advantages over the other kinds for the reason the base is the portion most liable to breakage, and is separate from the more expensive graduated neck. One could have a large number of the bases and not require more than a dozen of the graduated necks to operate them successfully.

Testing Cream.

Sampling.

The first and one of the most important parts of the process is sampling the cream, for it is plain that unless this is properly done and the portion taken for the test correctly represents the whole, the results that follow must necessarily be incorrect. The lot of cream to be sampled should be put in a can or some vessel sufficiently large to hold it all, and another vessel of equal size being at hand, it should be turned alternately from one to the other four or five times to thoroughly mix and make it homogeneous. The sample must be immediately taken after the mixing is done, and put in a vessel properly labeled and suitable for the purpose. A half pint fruit jar answers the purpose well, which must be filled full to avoid churning.

How often should tests be made?

In order to be *very* accurate and ascertain exactly the amount of fat in each patron's cream, it would be necessary to take a sample from every lot collected—a definite amount, 1 oz. for every inch or quart furnished, should be taken. That is, if a patron furnishes

six quarts to-day six ounces should be taken for the sample, and if he furnishes ten quarts to-morrow ten ounces should be taken for the sample.

These samples can be kept sweet in an ice chest for a week and then be thoroughly mixed together and tested. The result will accurately represent the per cent. of fat in the cream for that week. Many creameries cannot afford the time to collect samples and make tests so often, and it is not necessary if the patrons will exercise a little care to keep the water surrounding the milk cans always at the same temperature as nearly as possible. A test made once in two or three weeks will then suffice and give a sufficiently accurate basis on which to value the cream. It would be advisable to take samples for three successive days and mix them for the test. This would give a more accurate result than if only one sample was taken.

Performing the test.

With sweet cream that is not frothing, the method does not vary from that described for milk when the test bottle like No. 2 is used. A copy of these directions is furnished with each machine so a description is not necessary here. In adding hot water to the test bottles the first time, I find it most convenient to fill them to about the 20 per cent. mark, then one can easily see how much to add the second time to bring the fat where it can be measured. The measuring pipette is the same as that used for milk except it has two marks on it. The lower one (17.6) is to be used in measuring milk, the upper one (18) for measuring cream. From this latter mark the pipette delivers 18 grams of cream, raised in cans submerged in cold water, with sufficient accuracy for all practical purposes. For testing richer cream, a correction must be made because of the weight of cream delivered by the pipette decreases as the per cent. of fat increases.

For a scale reading of 25 per cent. add 0.15 per cent.; for a scale reading of 30 per cent. add 0.3 per cent. Readings between or above these may be corrected proportionately.

If the cream to be tested has become sour and curdled so it can not be handled with a pipette, it can be rendered mobile by placing the jar containing it in water and heating the whole to about 125° F., then passing the cream through fine wire gauze, (a flour sieve will do very well for the purpose.) Any lumps that remain on the sieve may be rubbed through with the finger. After passing the warm cream through the sieve two or three times, it will after

cooling, be in condition to measure with the pipette. On account of the small particles of curd, sour cream adheres much more to the walls of the pipette than sweet cream, therefore a little water (4 or 5 c.c.) must be used to rinse the pipette into the test bottle. Unless this is done the results will be from 0.2 to 0.4 per cent. too low. About 20c. c. of acid should be used when the pipette is rinsed. When the cream is frothing badly and contains a large amount of air or gas bubbles, as is sometimes the case with cream that is very sour or taken from a separator, it cannot be accurately measured but must be weighed. The writer has made several tests when the error in measuring frothy cream was over 5 per cent. of the total fat.

The only accurate method to pursue in such cases is to weigh the cream, and this can be very easily done by any one who has skill enough to make the test. A good little scale for the purpose is made by the Springer Tortion Balance Co., 92 Reade St., N. Y. Their No. 302 Handy Scale, costing about $4.00 with a weight that when put on the 8 oz. notch weighs 18 grams, is sufficiently accurate, and very convenient. We would advise creameries using this test to get a scale for the purpose mentioned, for there will be instances when it will save much time and trouble. The method of using the scale is very simple. The empty test bottle is set on the pan and counterpoised by means of the ounce weight and screw at the end of the scale arm; then the 18 gram weight is put on the 8 oz. notch, the pipette filled with cream a little above the mark and emptied into the test bottle until it is nearly all in, when the finger is pressed on the top of the pipette sufficiently to allow the cream only to drop slowly till the scale turns. One can weigh with a little practice about as rapidly as he can measure. This scale will also be very convenient in testing butter and cheese, as with solids it is necessary to weigh out the portions for the test.

In using the test bottle No. 3 the method is slightly modified in the latter part of the process. The base portion, into which has been measured the cream and acid, is put in the centrifugal machine and whirled for five minutes the same as with the ordinary bottles. As much hot water is then added as the base will hold without danger of spilling, and whirled for two or three minutes more, to collect the fat on the top of the water. The base is then taken and connected with the graduated neck by a piece of rubber tubing. The whole is then put in a tank or pail of water, heated to about 110 to 120 F. and the fat raised into the neck by

turning gently down the side hot dilute acid in sufficient quantity to fill the bottle to about the 34 mark. The fat usually rises and forms a compact column in two or three minutes so that by the time the 10th or 12th bottle is put into the warm water, the first can be read, giving directly the per cent. of fat.

The dilute acid consists of one part by volume of strong acid to one part of water. In mixing, the water must always be put in the vessel first and the acid turned into it. If used immediately it will need no extra heating, as sufficient heat is developed in the mixing. We have only had opportunity to make 12 or 15 tests with this bottle, but they seem to indicate that it is accurate as can be seen by the table below.

One cannot work quite as rapidly as with bottle No. 3 therefore we would advise its use only on very rich cream containing over 25 per cent. of fat.

This form of bottle (No. 3.) can be used in the regular size machine.

Where To Obtain The Apparatus.

Arrangements have been made with Cornish, Curtis & Greene, Fort Atkinson, Wis., manufacturers of the milk test apparatus, to furnish the modified apparatus to parties who may desire it at about the same price as the ordinary form.

Parties ordering the cream tester, must be particular to mention what they want or otherwise they may receive the wrong machine. Any of the pieces of glass-ware can be obtained of Emil Greiner, N. Y., and should be ordered by number, then no mistake can be made.

Cream Test bottle No. 1 is for use in the regular size milk testing machine and reads to 23 per cent.

Cream Test bottle No. 2 is for use in the machine especially made for the purpose and reads to 25 per cent.

Cream Test bottle No. 3, is for testing rich cream, can be used in either machine and reads to 35 per cent.

Sulphuric acid can be obtained of wholesale druggists, or dealers in chemicals. The Cochrane Chemical Co., Boston, Mass., sells commercial acid, specific gravity, 1.835, in carboy lots at very reasonable prices. Acid of this strength should be slightly diluted by adding about twenty parts of acid to one part of water by volume.

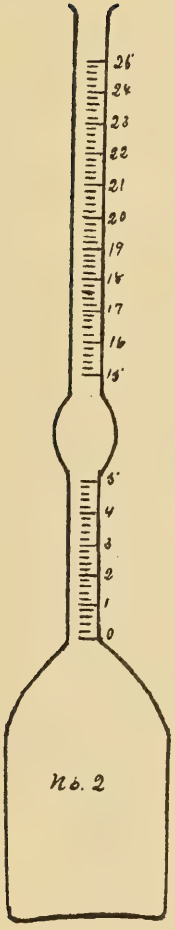
	Gravimetric Method.	Test Bottle with Bulb Neck.	Test Bottle with Separable Neck.
Cream No. 1.....	18.4	18.4	18.45
" "		18.35	18.40
" "			18.35
" "			18.40
" No. 2.....	14.3	14.1	14.0
" "	"	14.2	14.3
" "	"	14 1	
" "	"	14.3	
" No. 3.....	19.6	19.3	19.3
" "	19.7	19.3	19.5
" "	"	19.2	
" "	"	19.7	
" "	"	19.6	
" "	"	19.8	
" No. 4.....	18.62	18.4	
" No. 5.....	18.6	18.5	
" No. 6.....	20.4	20.1	20.0
" No. 7.	19.75	19.6	19.6
" "	"	19.6	19.8
" "	"	19.8	19.8
" "	"	19.9	19.9
" "	"	19.7	19.7

NOTE.—The object of this bulletin is to call attention to an accurate and rapid method of determining the percentage of fat in milk and cream. The apparatus as originally described by Dr. Babcock has been modified by Mr. Bartlett to meet the needs of creamery work in Maine and the new forms of testing flasks that have been devised are favorably regarded by Dr. Babcock. The Experiment Station does not assume that the managers of creameries are ready to value their patrons cream on the basis of the actual percentages of fat, neither does it propose at this time to urge such a course, for that is a purely business matter, but it seems very desirable that in case any creamery management should conclude to apply the only just standard of valuation, some practical method for doing this should be at hand. This bulletin presents such a method.

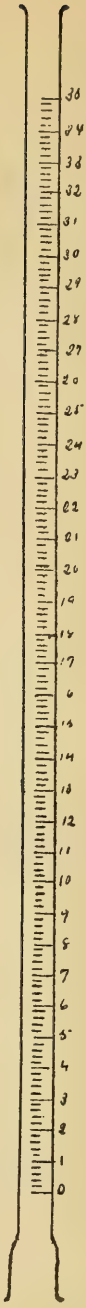
Should any creamery manager or private dairyman wish to purchase and put into operation the Babcock apparatus, the Experiment station will be glad to render all the assistance possible, either through suggestions about the purchase of, or instruction in the use of, the apparatus. Prompt attention will be given to all inquiries in regard to the matter.

W. H. JORDAN.
DIRECTOR.

ORONO, ME.,
Sept. 1st, 1891.


No. 2


No. 3



FURTHER REMARKS ON THE BABCOCK CREAM TEST.

J. M. BARTLETT.

Since Bulletin No., 3 was issued, many inquiries from parties interested in creameries have been received, and while a few creameries have already obtained and are successfully using the Babcock test, there still seems to be a grave doubt in the minds of some as to the practicability of applying a test that gives the value of the cream in butter fat instead of in butter. Again, when the cream is bought by the inch, measured in the cans as it stands on the milk, and then is sampled for the test after its volume has been increased by a small amount of skimmed milk drawn off in the skimming, the per cent. of fat obtained is too small. In regard to the first mentioned difficulty, it is unnecessary to consider the amount of butter the cream will make; nevertheless, if some insist on using the butter valuation, they will not come far from the truth if they consider that butter is 85 per cent. fat, or that 85 pounds of fat will make one hundred pounds of butter.

Cream for butter making is only valuable for the amount of butter fat it contains, and there seems to be no good reason why cream that contains 30 per cent. fat should not make twice as much butter as that containing 15 per cent. and why the one is not worth twice as much per inch as the other. We therefore claim that the only true basis for valuation is the butter fat content.

Cream from the milk of different cows or even herds, raised by the cold deep setting process, often varies five or six per cent. in fat under the most favorable conditions. If, then, a creamery buys cream at 15 cents an inch and Mr. A's cream contains 20 per cent. butter fat and Mr. B's 25 per cent., then A receives 75 cents for the same butter fat for which B receives but 60 cents.

It certainly seems to be more just and business like to pay a fixed price per unit for butter fat of known value, than to pay uniform rates per unit for cream of unknown value. Objections to the fat valuations have also been made on the ground that some cream churns with difficulty, especially that from cows advanced in lactation. This would be a valid objection providing each lot of cream was churned by itself, but it has been pretty well proved by experiment that when cream of poor churning qualities is ripened and churned with good cream, the separation of butter is just as complete, and no more fat is left in the butter milk, than when all good cream is churned.

In regard to making the test when cream is bought by the inch, it can be said that it makes no difference whether the cream is bought by the inch, gallon, or pound. If, according to the common practice in this State, the cream is measured as it stands on the milk in the can, all that is necessary is to draw the cream off into another can or pail of the proper diameter and make a second measurement in order to know how much milk has been drawn with it. The sample is taken from the thoroughly mixed cream after it is drawn off and having the two measurements the calculations is very simple.

If the cream measured 8 inches in the can and 10 inches after being drawn off with some skim milk and tested 20 fat, then to find the per cent. of fat in the cream before any milk was mixed with it we have the simple proportion 8 :10 : :20 :x.

X in this case equals 25 per cent.

If a patron of a creamery furnished 100 inches of cream for a week that tested as above, then he would be entitled to 25 units of butter fat.

Some creameries draw the cream off into a collector's pail before measuring, while others buy it by the gallon. With these methods a second measurement is not necessary when the sample is taken for the test.

Some creameries are co-operative and the butter receipts are divided among its patrons. In such cases the test can be used equally well for a proper division of the proceeds. Suppose A. B. and C. are patrons and

A furnishad	100	in.	cream,	testing 20%	= 20 units.
B "	200	"	"	" 25%	= 50 "
C "	500	"	"	" 18%	= 90 "
	Total,				160 "

From this cream 380 lbs. of butter are made.

Then A's	share	is	2-16	of 380 lbs.,	= 47½ lbs.
B's	"		5-16	" 380 "	= 118¾ "
C's	"		9-16	" 380 "	= 213¾ "



INTERIOR OF EXPERIMENT STATION LABRATORY, LEFT SIDE.



INTERIOR OF EXPERIMENT STATION LABRATORY, RIGHT SIDE.

APPENDIX.

Hungarian Grass, CXXI.

Sheep 1.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Fed daily	556.	504.4	51.5	61.4	170.5	254.	18.4
Excreted daily	216.8	184.5	32.3	24.4	58.9	92.9	8.3
Digested	339.2	319.9	19.2	37.0	111.6	161.1	10.1
Per cent. digested	61.0	63.4	37.2	60.2	65.4	63.5	54.9
Sheep 2.							
Fed daily	556.	504.4	51.5	61.4	170.5	254.	18.4
Excreted daily	208.4	176.	32.4	24.9	56.5	84.9	9.6
Digested	247.6	328.4	19.1	36.5	114.0	169.1	8.8
Per cent. digested	62.5	65.1	37.0	59.1	66.8	66.7	47.8
Sheep 3.							
Fed daily	556.	504.4	51.5	61.4	170.5	254.	18.4
Excreted daily	205.	175.3	29.6	22.3	54.8	89.2	9.1
Digested	351.0	329.1	21.9	39.1	115.7	164.8	9·3
Per cent. digested	63.1	65.2	42.5	63.6	67.2	64.8	50.5
Sheep 4.							
Fed daily	556.	504.4	51.5	61.4	170.5	254.	18.4
Excreted daily	183.2	157.2	26.	20.6	48.1	80.3	8.0
Digested	372.8	347.2	25.5	40.8	122.4	173.7	10.4
Per cent. digested	67.0	68.8	49.5	66.4	71.7	68.4	56.

Hungarian Hay, CXXVIII.

Sheep 1.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Fed daily	655.5	598.8	56.6	70.9	191.7	311.4	24.8
Excreted daily	228.9	199.4	29.5	28.4	60.7	101.3	8.9
Digested	426.6	399.4	27.1	42.5	131.0	210.1	15.9
Per cent. digested	65.8	66.8	47.9	59.9	68.5	67.4	63.9
Sheep 3.							
Fed daily	655.5	598.8	56.6	70.9	191.7	311.4	24.8
Excreted daily	234.1	204.	30.1	28.3	63.5	103.1	9.
Digested	421.6	394.8	26.5	42.6	128.2	208.3	15.8
Per cent. digested	64.3	65.9	46.9	60.0	66.8	66.9	63.8

Southern Corn Fodder, CXXVII.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Sheep 2.							
Fed daily	504.7	461.5	43.1	55.5	154.7	256.4	14.8
Excreted daily	149.6	131.7	18.	18.8	38.7	70.0	4.1
Digested	355.1	329.8	25.1	36.7	116.0	166.4	10.7
Per cent. digested	70.3	71.4	58.2	66.1	74.9	70.4	72.3
Sheep 4.							
Fed daily	504.7	461.5	43.1	55.5	154.7	236.4	14.8
Excreted daily	158.4	139.8	18.7	19.6	40.8	74.8	4.5
Digested	346.3	321.7	24.4	35.9	113.9	161.6	10.3
Per cent. digested	68.6	69.8	56.6	64.7	73.6	68.7	69.6

Field Corn Fodder, CXXV.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Sheep 1.							
Fed daily	403.2	372.5	30.7	45.2	102.5	211.4	13.3
Excreted daily	113.6	100.3	13.4	16.	24.3	56.2	3.8
Digested	289.6	272.2	17.3	29.2	78.2	155.2	9.5
Per cent. digested	71.8	73.7	56.3	64.6	76.3	73.4	71.4
Sheep 3.							
Fed daily	403.2	372.5	30.7	45.2	102.5	211.4	13.3
Excreted daily	123.1	107.6	15.5	18.5	25.6	59.4	4.1
Digested	280.1	264.9	15.2	26.7	76.9	152.0	9.2
Per cent. digested	69.4	71.1	49.5	59.0	75.0	71.9	69.1

Sweet Corn Fodder, CXXVI.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Sheep 2.							
Fed daily	407.2	398.6	28.6	55.1	104.4	203.5	15.7
Excreted daily	124.7	106.7	18.	21.9	24.1	57.4	3.3
Digested	282.5	291.9	10.6	33.2	80.3	146.1	12.4
Per cent. digested	69.3	73.2	37.0	60.2	76.9	71.8	78.3
Sheep 4.							
Fed daily	407.2	398.6	28.6	55.1	104.4	203.5	15.7
Excreted daily	121.	104.4	16.6	20.1	24 4	55.8	4.0
Digested	286.2	294.2	12.0	35.0	80.0	147.7	11.7
Per cent. digested	70.2	73.9	41.9	63.5	76.6	72.5	74.5

Timothy—Mixed CXL.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Sheep 1.							
Fed daily	646.6	614.3	32.3	48.1	211.0	324.3	30.8
Excreted daily	266.5	242.5	24.0	28.	97.2	109.7	7.4
Digested	380.1	371.8	8.3	20.1	113.8	214.6	23.4
Per cent. digested	58.7	60.5	25.7	41.9	53.9	66.1	75.9
Sheep 2.							
Fed daily	646.6	614.3	32.3	48.1	211.0	324.3	30.8
Excreted daily	283.5	261.3	22.3	26.9	106.4	118.9	8.9
Digested	363.1	353.0	10.0	21.2	104.6	205.4	21.9
Per cent. digested	56.1	57.4	30.9	44.0	49.6	63.3	71.1
Sheep 3.							
Fed daily	646.6	614.3	32.3	48.1	211.0	324.3	30.8
Excreted daily	243.	222.5	20.5	24.2	83.7	107.3	7.5
Digested	403.6	391.8	11.8	23.9	127.3	217.0	23.3
Per cent. digested	62.4	63.7	36.5	49.8	60.3	66.9	75.6
Sheep 4.							
Fed daily	646.6	614.3	32 3	48.1	211.0	324.3	30.8
Excreted daily	276.9	252.9	24.1	28 4	80.4	136.2	7.8
Digested	369.7	361.4	8.2	19.7	130.6	188.1	23.0
Per cent. digested	57 1	58 8	25.4	40.9	61.9	58.0	74.6

Timothy Hay, CXLI.

Sheep 1.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Fed daily	646.6	610.	36.5	46.8	212.4	324.2	26.6
Excreted daily	274.8	251.3	23.5	25.6	99.5	118.9	7.3
Digested	371.8	358.7	13.0	21.2	112.9	205.3	19.3
Per cent. digested	57.5	58.8	35.6	45.3	53.1	63.3	72.5
Sheep 2.							
Fed daily	646.6	610.	36.5	46.8	212.4	324.2	26.7
Excreted daily	266.9	243.5	23.4	26.5	98.8	110.3	7.8
Digested	379.7	366.5	13.1	20.3	113.6	213.9	18.9
Per cent. digested	58.7	60.0	35.9	43.3	53.5	65.9	70.7
Sheep 3.							
Fed daily	646.6	610.	36.5	46.8	212.4	324.2	26.6
Excreted daily	267.7	246.5	21.2	23.5	96.7	117.8	8.2
Digested	378.9	363.5	15 3	23.3	115.7	206.4	18.4
Per cent. digested	58.6	59.6	41.9	49.8	54.5	63.7	69.2
Sheep 4.							
Fed daily	594.6	560.4	34.2	43.9	194.5	297.	24.9
Excreted daily	229.7	211.1	18.6	21.1	81.0	100.8	8.2
Digested	364.9	349.3	15.6	22.8	113.5	196.2	16.7
Per cent. digested	61.3	62.3	45.6	51.9	58.3	66.0	67.0

Sugar Beets, CXXXIII.

Sheep 1.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Fed in hay, CXL, daily	461.8	438.8	23.	34.4	750.7	231.6	22.
Fed in beets daily	325.	302.8	22.2	31.2	17.4	251.4	2.8
Total fed	786.8	741.6	45.2	65.6	168.1	483.	24.8
Excreted daily	210.5	181.6	28.8	22.3	67.7	84.7	7.0
Total digested	576.3	560.0	16.4	43.3	100.4	398.3	17.8
Digested from hay	270.1	263.7	6.8	15.2	85.	147.3	16.3
Digested from beets	306.2	296.3	9.6	28.1	15.4	251.0	1.5
% digested from beets	94.2	97.6	43.2	90.0	88.5	99.8	53.5
Sheep 3.							
Total fed	786.8	741.6	45.2	65.6	168.1	483.	24.8
Excreted daily	208.7	174.9	33.8	21.5	63.3	82.7	7.2
Total digested	578.1	566.7	11.4	44.1	104.8	400.3	17.6
Digested from hay	270.1	263.7	6.8	15.2	85.	147.3	16.3
Digested from beets	308.	303.0	4.6	28.9	19.8	253.0	1.3
% digested from beets	94.8	99.9	20.7	92.6	11.3	10.0	46.4

Mangolds, CXXXII.

Sheep 2.

	Dry substance.	Organic matter.	Ash	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Fed in hay, CXL, daily	461.8	438.8	23.	34.4	150.7	231.6	22.0
Fed in beets daily	234.6	212.4	22.2	24.8	14.6	170.6	2.2
Total fed	696.4	651.2	45.2	59.2	165.3	402.2	24.2
Excreted daily	245.4	211.7	33.7	26.7	76.4	99.9	8.7
Total digested	451.0	439.5	11.5	32.5	88.9	302.3	15.5
Digested from hay	270.1	263.7	6.8	15.2	85.	147.3	16.3
Digested from beets	180.9	175.8	4.7	17.3	39.	155.0	.....
% digested from beets	77.1	82.7	21.1	69.7	26.8	90.8	.....

Sheep 4.

Total fed	696.4	651.2	45.2	59.2	165.3	402.2	24.2
Excreted daily	238.5	202.7	35.8	24.2	71.7	98.1	8.6
Total digested	457.9	448.5	9.4	35.0	93.6	304.1	15.6
Digested from hay	270.1	263.7	6.8	15.2	85.	147.3	16.3
Digested from beets	187.8	184.8	2.6	19.8	8.6	156.8	.....
% digested from beets	80.	87.0	11.7	79.8	58.8	91.9	.....

Rutabagas, CXXX.

Sheep 1.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Fed in hay, CXL, daily	461.8	438.8	23.	34.4	150.7	231.6	22.
Fed in turnips daily	219.	204.6	14.4	17.8	20.	156.	10.8
Total fed	680.8	643.4	37.4	52.2	170.7	387.6	32.8
Excreted daily	213.5	189.4	24.	21.7	68.2	92.9	6.6
Total digested	467.3	454.0	13.4	30.5	102.5	294.7	26.2
Digested from hay	270.1	263.7	6.8	15.2	85.	147.3	16.3
Digested from turnips	197.2	190.3	6.6	15.3	17.5	147.4	9.9
% digested from turnips	90.0	93.0	45.8	85.9	87.5	94.4	91.6

Sheep 3.

Total fed	680.8	643.4	37.4	52.2	170.7	387.6	32.8
Excreted daily	225.5	197.2	28.2	23.7	73.5	91.8	8.2
Total digested	455.3	446.2	9.2	28.5	97.2	295.8	24.6
Digested from hay	270.1	263.7	6.8	15.2	85.	147.3	16.3
Digested from turnips	185.2	182.5	2.4	13.3	12.2	148.5	8.3
% digested from turnips	84.5	89.2	16.7	74.7	61.	95.1	76.8

English Flat Turnips, CXXXI.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Sheep 2.							
Fed in hay, CXL, daily	461.8	438.8	23.	34.4	150 7	231.6	22.
Fed in turnips daily	195.2	176.8	18.4	22.	20.4	126.4	8.
Total fed	657.0	615.6	41.4	56 4	171.1	358.0	30.
Excreted daily	209.8	187.	22.8	22.6	67.9	89.3	7.1
Total digested	447.2	428.6	18.6	33.8	103.2	268.7	22.9
Digested from hay	270.1	263.7	6.8	15.2	85.	147.3	16.3
Digested from turnips	177.1	164.9	11.8	18.6	18.2	121.4	6.6
% digested from turnips	90.7	93.2	64.1	84.5	89.2	96.0	82.5
Sheep 4.							
Total fed	657.0	615.6	41.4	56.4	171.1	358.0	30.
Excreted daily	201.6	176.8	24.8	20.3	62.2	88.	6.3
Total digested	455.4	438.8	16.6	36.1	108.9	270.0	23.7
Digested from hay	270.1	263.7	6.8	15.2	85.	147.3	16.3
Digested from turnips	185.3	175.1	9.8	20.9	23.9	122.7	7.4
% digested from turnips	94.9	99.0	53.2	95.0	11.7	97.0	92.5

Gluten Meal, CXXXIV.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Sheep 2.							
Fed in hay, CXLI, daily	461.8	435.7	26.1	33.4	151.7	231.6	19.
Fed in gluten meal daily	269.4	266.4	3.	92.4	2.9	141.7	29.3
Total fed	731.2	702.1	29.1	125.8	154.6	373.3	48.3
Excreted daily	230.2	209.7	20.5	26.6	74.5	98.5	10.
Total digested	501.0	492.4	8.6	99.2	80.1	274.8	38.3
Digested from hay	272.9	262.3	10.4	15.8	83.1	149.8	13.2
Digested from gluten meal	228.1	230.1	.....	83.4	.....	125.0	25.1
% digested from gluten meal	84.7	86.3	.....	90.2	.....	88.2	85.6
Sheep 4.							
Fed in hay, CXLI, daily	413.5	389.6	23.8	30.8	135.2	206.3	17.4
Fed in gluten meal daily	269.4	266.4	3.	92.4	2.9	141.7	29.3
Total fed	682.9	656.0	26.8	123.2	138.1	348.0	46.7
Excreted daily	195.4	176.5	18.9	32.0	54.3	82.	8.2
Total digested	487.5	479.5	7.9	91.2	83.8	266.	38.5
Digested from hay	244.4	234.5	9.4	14.5	74.1	133.5	12 1
Digested from gluten meal	243.1	245.0	.....	76.7	9.7	132.5	26.4
% digested from gluten meal	90.2	91.9	.....	83.0	33.4	93 5	90.1

Wheat Bran, CXXXV.

Sheep 1.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Fed in hay, CXLI, daily	461.8	435.7	26.1	33.4	151.7	231.6	19.0
Fed in wheat bran daily.....	264.8	246.8	18.	46.5	29.	156.	15.3
Total fed.....	726.6	682.5	44.1	79.9	180.7	387.6	34.3
Excreted daily.....	280.7	250.9	29.9	25.6	84.	129.1	12.
Total digested	445.9	431.6	14.2	54.3	96.7	258.5	22.3
Digested from hay	272.9	262.3	10.4	15.8	83.1	149.8	13.2
Digested from wheat bran	173.0	169.3	3.8	38.5	13.6	108.7	9.1
% digested from wheat bran ..	65.3	68.5	21.1	82.7	46.9	69.6	59.5

Sheep 3.

Total fed.....	726.6	682.5	44.1	79.9	180.7	387.6	34.3
Excreted daily.....	309.6	273.3	36.3	26.2	90.2	146.3	10.6
Total digested	417.0	409.2	7.8	53.7	90.5	241.3	23.7
Digested from hay	272.9	262.3	10.4	15.8	83.1	149.8	13.2
Digested from wheat bran	144.1	146.9	.....	37.9	7.4	91.5	10.5
% digested from wheat bran ..	54.4	59.5	.....	81.5	25.5	58.6	68.6

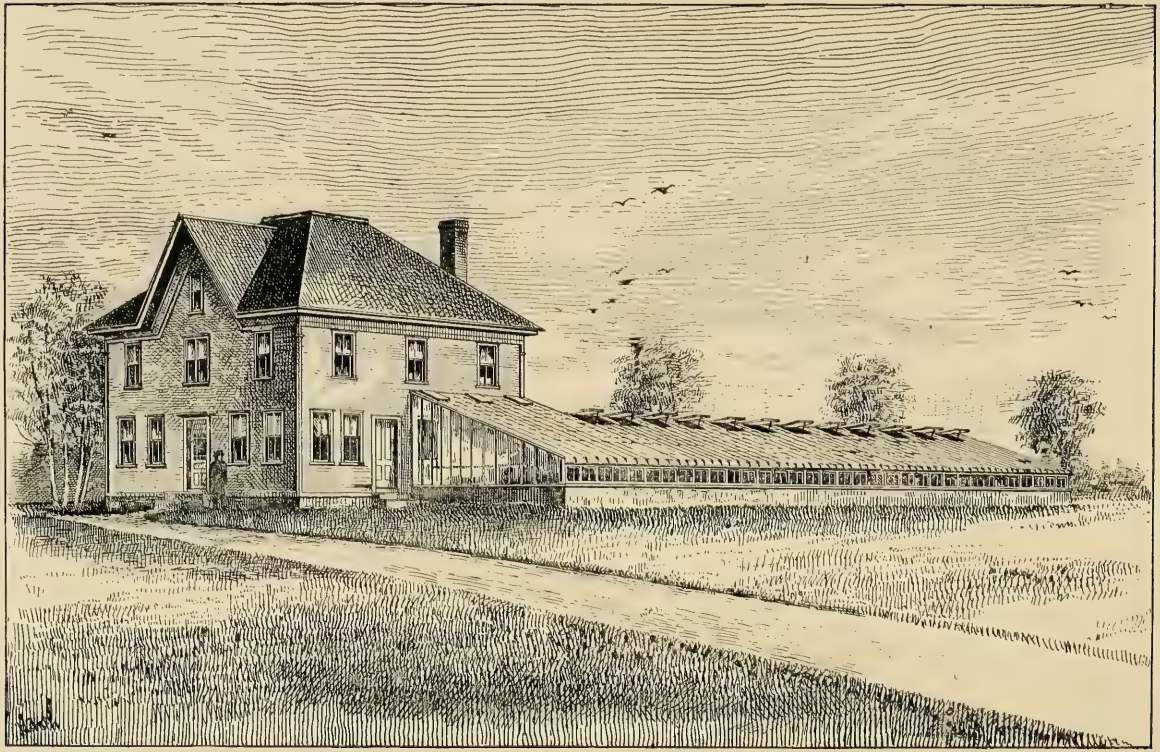


PLATE I. FORCING HOUSE, MAINE EXPERIMENT STATION.

REPORT OF THE HORTICULTURIST.

Prof. W. M. Munson.

As noted in the reports of the Experiment Station for 1889 and 1890, several varieties of orchard fruits and small fruits have been obtained by the Station, and some have been distributed to different parts of the state. Previous to the present year, however, there had been no organized department of horticulture, and as the work came under my charge in February, the past year has necessarily been largely taken up with pioneer work.

At the time the department came under the charge of the writer, a forcing-house, 20x100 feet, had just been completed. (See Plate I.). The house is well constructed. The frame work is of cypress, and the walls are of grout, while the building is heated by hot water. The house is divided in the center by a glass partition, and the hot water pipes have been so arranged that one part may be kept at a much lower temperature than the other. The warm house is arranged for bottom heat, and the cool house for over-head heat.

At the present time the warm house is used for tomatoes, cucumbers and beans; while the other is devoted to lettuce, radishes, cauliflowers and other plants requiring the lower temperature. Plate II is from a photograph of the interior of the cool house, as it appeared in December.

The building in connection with the forcing house, was erected during the year at a cost of about one thousand dollars, a part of the expense being borne by the college. The building contains, besides the furnace room and a room for the smaller garden tools, a general laboratory and work room, a small office, a room for herbarium work, and a well appointed photographic studio. In all of our work photography is made to play an important part as a means of preserving accurate records.

The grounds devoted to this division include about ten acres of land of varied character. More than half of this area is devoted to fruit culture. The apple orchard contains about 115 varieties, 52 of which are Russian varieties obtained from Professor Budd, of Iowa. There are also 23 varieties of pears, 30 of

plums, 12 of cherries: also, quinces, 2 varieties; blackberries 9 varieties; raspberries 13 varieties; currants 7 varieties; gooseberries 3 varieties; strawberries 17 varieties. As the college campus is under the supervision of the writer, a considerable amount of experimental work is done with ornamental plants on other areas.

Variety testing, as such, either of fruits or vegetables, is not made a leading feature of our work. While we cultivate most of the novelties which promise well for the trying climate of the state, the more important part of our work is perennial, and has to do with the investigation of certain cultural problems, and of certain of the laws of plant variation. While it is designed to make the work practical, so far as possible, we must recognize the fact that any work to be of permanent value, must be based on sound principles. With this idea in mind, we are making a special study of the effects of climate on plant variation. We are also making an extensive study of the effects of pollination. Practical application of the principles involved, and of the facts learned, is made in our attempts to ameliorate certain of our native fruits, and to extend the list of fruits and vegetables which may be profitably grown in this region. Numerous crosses and hybridizations have been made and valuable results are indicated.

Our work with egg plants commenced two years ago, and the past season some two hundred plants, of the second generation from the crosses, were grown on our grounds. Selections have been made from the more promising of these, and the work will be continued and extended.

The forcing of vegetables under glass is made an important feature of our work. It is believed that from a practical point of view, this line of work is destined to become of great importance to the people of the state. While a study of methods of culture is made, and also of varieties suitable for forcing, at the same time, the material thus grown furnishes the best possible opportunity for conducting the work of crossing, as the conditions of growth are under control. We are now forcing tomatoes, cucumbers, beans, lettuce, radishes, cauliflowers and some others. Plate III is a view of the tomato house as it appeared about the first of January.

Recognizing the importance of the fruit industry of the state, and the necessity of combating the insect and fungous enemies which are proving a serious obstacle to success, experiment

have been conducted during the year to determine the effectiveness of certain insecticides and fungicides. The results obtained are very encouraging and the work will be continued and extended during the ensuing year.

Attention is being given to the amelioration of our native fruits, and to developing the possibilities of fruit culture in the more trying localities of the State.

Following is given somewhat in detail a part of the work of the year. Some of the work being incomplete, the report will be made later.

THE VEGETABLE GARDEN.

Owing to the fact that the soil intended for vegetable gardening was badly infested with "witch grass," it was thought best to subdue the land before undertaking much work with vegetables. Our attention during the past season has been given chiefly to certain points in the culture of cabbages, tomatoes and egg plants.

I. Notes of Cabbages.

Some twenty varieties of early cabbages were grown; the special design being to study the effect of different methods of culture, and to compare the relative merits of seed from the east, and from the extreme northwest, as well as to try some of the newer varieties not yet placed on the market.

1. *Culture:* In general, cabbages for early use should be started in hot beds or forcing houses from the first to the middle of April. To prevent crowding, transplant once or twice before setting in the open ground in May. If the plants are "hardened off," *i. e.* gradually exposed to lower temperatures, before being placed out of doors, they will stand a light frost without injury. Frequent cultivation is advisable.

2. *Influence of Transplanting:* It is a common practice among gardeners to handle certain vegetables from one to three or four times before setting in the open field; the object being to render the plants "stocky," and, it is thought, better able to withstand the shock of final removal to the field. The operation is also thought to hasten the maturity of the plants, and to increase the production of fruit. How far these impressions are correct, we are not as yet prepared to state. Some contend that this manipulation of the plants tends to dwarf them, thereby reducing the amount of fruit, or in case of cabbages, the size of the head.

It is the practice of the writer to handle cabbages, tomatoes and other vegetables started under glass, in pots, so far as possible. In this way the plants suffer little or no check in transplanting, and with some sorts at least, better results are obtained. Plants grown in boxes or flats, are necessarily mutilated each time they are handled.

To determine the extent of the influence of the different methods of treatment on the development of the cabbage, a portion of the plants were handled in pots and the remainder in flats till ready for the final transfer to the field. The plants handled in pots were removed from the seed-flats to 3-inch pots, and later to 4-inch pots. Those handled in boxes were placed about two inches apart at the first transplanting, and about four inches each way at the second. When put out in the field, all were placed in rows three feet apart, and two feet apart in the row.

Table I shows the results obtained.

TABLE I.

VARIETIES.	No. of heads.	Heaviest head. lbs.	Lightest head. lbs.	Av'ge weight. lbs.	No. of heads cracked.	No. of immature heads.	No. of plants not cut.	Ratio.	Remarks.
JERSEY WAKEFIELD. (Thorburn.)									Cut July 28.
Pots	25	3.0	1.0	1.8	2	2		1.38	
Boxes	24	2.0	.7	1.3	2	1	4	1.00	
JERSEY WAKEFIELD. (March.)									"
Pots	17	2.75	1.0	2.0	2	5	2	1.33	
Boxes	8	2.25	.75	1.5	1	2	2	1.00	
EARLY ETAMPES. (Thorburn.)									Cut Aug. 26
Pots	25	3.1	1.1	2.4	0	4		1.00	
Boxes	14	4.5	1.7	3.8	3	1		1.58	
BRUNSWICK. (Thorburn.)									"
Pots	14	7.4	3.0	5.0	0	0		1.22	
Boxes	11	5.9	2.1	4.1	0	0		1.00	
STEIN'S FLAT DUTCH. (Thorburn.)									"
Pots	18	11.9	6.4	8.1	6	0		1.00	
Boxes	15	11.7	5.5	9.1	1	0		1.11	

With three varieties, heads from the plants handled in boxes were lighter, and in two cases they were heavier than those from the pots. *Brunswick* averaged .9 lb. per head heavier from pot-grown plants, while *Flat Dutch* gave an equal difference in favor of the boxes.

Conclusion: From the results obtained, it appears that disturbing the roots in transplanting cabbages, has no marked effect on the size of the head or the time of maturity, if the plants are given good after treatment.

3. Influence of Deep and Shallow Setting, Combined with Other Treatments: It is commonly taught that cabbage plants should be set deeply; that long "leggy" plants will not produce good heads. From extensive trials at other experiment stations during the past two years, it has been pretty clearly shown that the practice of deep setting has not the importance commonly attached to it.† Having a few surplus plants, however, the question of deep and shallow planting was included with certain other cultural problems. The variety used was Jersey Wakefield.

Table II gives the results.

TABLE II.

HOW HANDLED.	Number cut.	Heaviest head. lbs.	Lightest head. lbs.	Av'ge weight. lbs.	No. of heads cracked.	No. of heads immature.	No. of plants not cut.	Remarks.
a.—Pots, deep, 3 times.....	17	2.75	1.00	**2.00**	2*	5	2	
b.—Pots, shallow, 3 times ...	19	2.25	.75	**1.58**	2*	5	1	* Slightly.
c.—Box, deep, 3 times.....	8	2.25	.75	**1.55**	1	2*	2	"
d.—Box, deep, 2 times	13	2.50	1.00	**1.50**	2	1*	2	"
e.—Box, shallow, 3 times....	8	1.62	1.12	**1.37**	0	0	4	
f.—Box, shallow, 2 times....	13	2.00	1.00	**1.29**	1	1	0	

The first column in the table shows the number of times the plants were handled, and the manner of handling. "Deep" indicates that the plants were set up to the seed leaves at the first transplanting, and still deeper at each subsequent handling. "Shallow," indicates that the plants were set no deeper than they naturally grew

† See Bulletins 15 and 25, Cornell University Experiment Station

in the seed flat. Seed was sown March 23. The plants transplanted three times were handled April 6, April 24, and May 19, when all were put out in the open field on clayey loam of only moderate fertility. Those transplanted twice were handled April 6 and May 19.

A study of the table will show, first of all, that plants grown in pots and set deeply gave decidedly the best results. This method of treatment seems specially suited to the variety under discussion. In previous trials we have observed that Jersey Wakefield has usually given better results when set deeply.

It will also be observed that from the plants handled three times, the average weight of the heads was invariably greater than from those handled twice. It is probable that the reason for this lies in the fact that the actual mutilation was necessarily less, when the plants were handled more frequently,—the root system being less widely extended.

Conclusion: The heaviest heads were obtained by frequent transplanting and by setting the plants deeply. This may not be a general rule applying to all varieties.

Frequent transplanting increased the average size of the heads.

4. *Varieties:* A good cabbage has a short stem; leaves placed close together, and having short petioles, thus leaving little open space about the stem. The blade should be large enough to extend more than half way around the head to avoid the soft spot often seen in the center. The leaves should also embrace each other very firmly. Firm, solid heads are less subject to the attacks of the "cabbage worm," than are loose, open ones. This fact is of no small importance in selecting a variety.

Most of the varieties grown are well known, and require no special description. A few may be mentioned, however, to direct the attention of planters to the more valuable ones for the home garden.

Jersey Wakefield. Small, conical, firm. The best of the very early varieties. This old variety, though popular for many years with market gardeners, is too often unknown in the average home garden.

Brunswick (Fottler's.) Medium size, depressed, very firm. Leaves closely set on the stem; blade well developed, second early. One of the best.

Early Summer: Medium size, nearly spherical, firm. About ten days later than Jersey Wakefield. Good.

Early York: Medium size, loose, open. Should have been discarded long ago.

Flat Dutch: Large, flattened, solid. A standard late variety.

Two new varieties were sent for trial by Francis Brill, Hempstead, N. Y. The names given both varieties, "Nonesuch" and "Worldbeater," are objectionable and would tend to make planters hesitate before selecting them.

Nonesuch: Light colored, very glaucus. Heads of medium size, flattened, resembling Early Summer. Stems short; leaves closely set, and well developed. Early. Worthy of further trial.

Worldbeater: Light colored. Head of medium size, spherical or oblong. Leaves much cut and wrinkled; not closely set on stem; petiole long.

Summary.

1. Disturbing the roots of cabbage in transplanting, appears to have no marked effect on the size of the head.

2. The best results were obtained by frequent transplanting.

3. In general, depth of setting seems to have little influence on the size of the heads; but Jersey Wakefield gave better results from deep setting.

4. Firmness is an important characteristic of a good cabbage, as such heads are less injured by attacks of the cabbage worm.

5. Of the older varieties, Jersey Wakefield, Brunswick, Early Summer, and Flat Dutch are good for general culture; Early York should be discarded.

6. Of the newer varieties tested, Nonesuch is promising.

II. Notes of Tomatoes.

1. *Culture:* One of the important problems in tomato culture for the state of Maine, is that of securing *earliness*. As a rule, plants purchased of the local dealers are drawn and "leggy," being crowded together in small boxes. When set in the field the shock is such that several weeks are required for the plants to recuperate; consequently no fruit sets till late in the season, and the larger portion of the crop is still unripe when the vines are killed by frost. In general, these weak, drawn plants are not worth setting.

Frequent "handling" or transplanting, is found to be the best method of securing strong, stocky, well developed plants. Some of the best cultivators combat this idea, but in our own experience the transplanting has been found beneficial. The practice of the writer is to sow the seed in "flats,"—shallow boxes about 16 by 24 inches and 3 inches deep—about the first of April. When the first true leaves have nicely started, or as soon as the plants begin to crowd, they are transferred to 2-inch rose pots. As the pots are so small, we usually plunge them in sphagnum to prevent too great extremes of moisture. As soon as the pots are well filled with roots—usually in two or three weeks—the plants are re-potted into 3-inch or 3 1-2-inch pots. Later they are again handled into 4-inch pots and given an abundance of room; being finally transferred to the open ground, from the first to the middle of June. If short of pots, we sometimes handle the plants in flats until they are ready for the final transfer. In this case they are usually placed about two inches apart each way at the first handling, and four or five at the second. By this treatment the roots are confined to a comparatively small space, and the plants suffer less severely when planted out. The plants are set in the field in rows five feet apart each way, and the horse cultivator is used freely.

2. *Effect of Early Setting:* It is commonly held that tomato plants should not be set out in the field till the cool nights of early summer are past—certainly not before the middle of June. The results of an experiment conducted last year, however, indicated that earlier setting was at least not detrimental, and might be beneficial.*

To test the matter further, fifteen plants of Perfection, as nearly alike as possible, were selected and given the same treatment while in the house. Five plants were set in the field on sandy loam having a southern aspect, May 18. Five more were placed by the side of these May 30, and the other five were set next to them June 8, when the main crop was planted out. Plants set May 18 and May 30 were injured by frost May 31.

The results were as follows:

	a. May 18.	*b.* May 30.	*c.* June 8.
Average number fruits per plant	47.0	33.0	20.0
Average weight of product, in pounds....	16.1	12.4	6.9
Average weight per fruit, in ounces.....	5.4	5.9	5.6

* Bulletin XXI Cornell University Experiment Station.

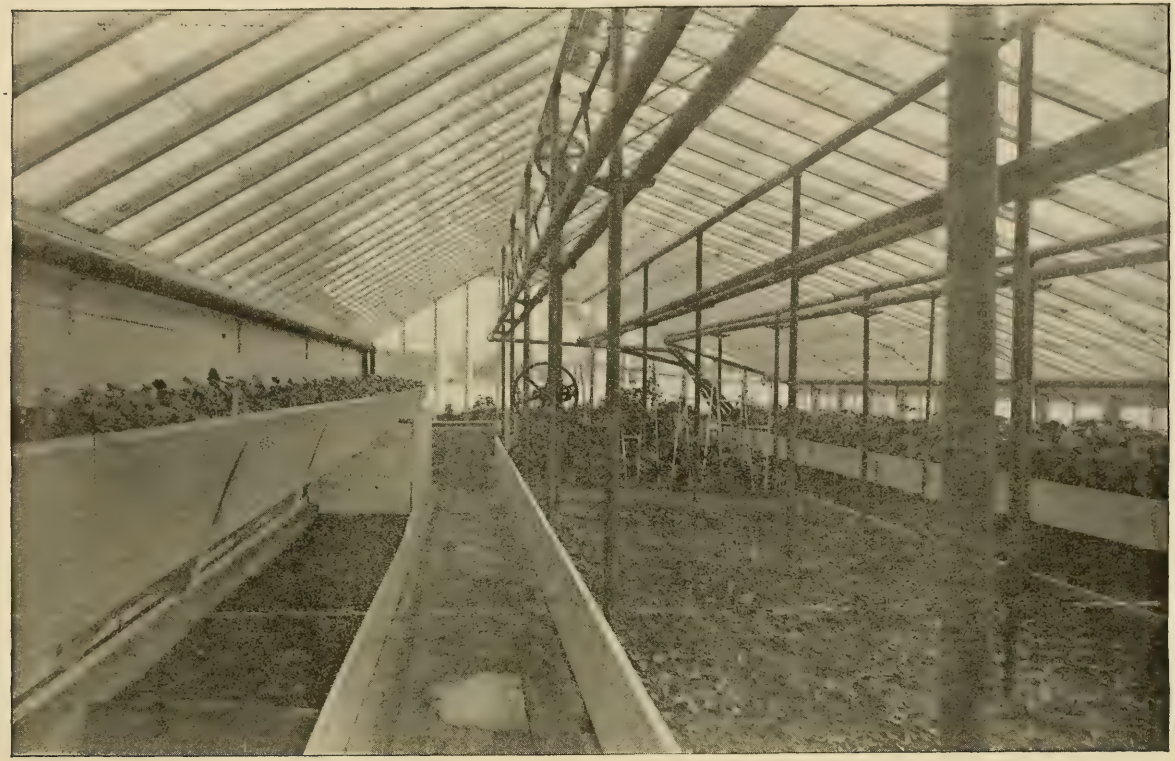


PLATE II. INTERIOR OF COOL HOUSE.

The total average product was in direct proportion to the earliness of setting. The relative earliness was also observed to follow the same order.

The total product of the five plants for the month of August was respectively:

	Number of fruits.	Weight. lbs.
a	31	8.5
b	25	7.4
c	14	4.2

The season was exceptionally long, but even so late as September 30, the earlier plants maintained their superiority. The last two pickings, Sept. 26 and 30, gave the following results:

	Number of fruits.	Weight. lbs.
a	163	5[illegible]
b	118	[illegible]
c	67	2

Conclusions: On warm, sandy soil, the earliness and productiveness of tomatoes was in direct ratio to the earliness of setting in the field.

A chill, and even a slight cutting by frost is not as fatal to success as is commonly supposed.

It is well, in practice, to set some plants in the field early in the season, holding others in reserve to replace the first if killed by frost.

3. *Effects of Trimming Tomatoes:* With a view to applying the principle that "checking growth induces fruitfulness," to the culture of tomatoes, several varieties were operated upon in 1890. The results, as a rule, indicated that trimming the vines is a profitable method of inducing earliness, and consequently of increasing the portion of the crop available. The total increase in the number of fruits ranged from 5.5 per cent. to 47.6 per cent.

During the past season the trial was repeated. Plants of *Perfection* and *Chemin Market* were used in the test. Twelve plants of the former and five of the latter were headed back July 24, Aug. 8, and Sept. 5. At each trimming the leading branches were shortened about six inches, and most of the side shoots below the first clusters of fruit were removed, the others being

shortened. The sunlight was thus freely admitted to the fruit, and picking was rendered much easier. The following figures are significant.

	Average No. fruits per plant, ripened Sept. 30.	Average weight of product in lbs.	Average weight of individual fruits, in ounces.	Per cent. gain by number.	Per cent. gain by weight.
*Perfection.					
Trimmed	45	17.1	6.1	36.3	44.0
Not trimmed	33	11.8	5.6		
Chemin.					
Trimmed	12	3.8	4.9	50.0	58.3
Not trimmed	8	2.4	5.0		

* A portion of the Perfection plants used in this test were set out in May, hence the two varieties should not be compared in this case.

The average number of fruits, and also the weight of the product was materially increased by trimming the vines. The size of individual fruits was increased in one case, but in the other there was a slight decrease.

Conclusions: Trimming tomato vines hastens maturity of the fruit, and consequently increases the portion of the crop which is available, or the apparent yield of the plants.

As the time required for the work is small, the practice will doubless be a good one for amateurs.

4. *Color of Fruit:* Numerous attempts have been made to improve upon the color of the fruit of the tomato. As the color is quite variable, and as the yellow varieties are sports from the red, it has been thought possible to secure a yellow fruit with a blush cheek. With this purpose in view, numerous crosses have been made between red and yellow varieties. In 1890, several successful crosses were made by Mr. C. W. Matthews of Cornell University, and seeds from one of these, in which Golden Queen was used as the pistillate parent and Ignotum as the male, were grown by the writer during the past season. The plants were very vigorous and productive, but failed to show any trace of the influence of the female parent. The fruit was in every way, as to form, color and size, typical of the true Ignotum. Similar results were obtained by Professor Bailey at the Cornell Experiment Station.

Observing a slight tendency on the part of Golden Queen, to vary in the desired direction, a selection was made in 1890. The past season the tendency was much more marked, and some very handsome fruits resulted. If the color can be fixed, the desired end will have been accomplished. It seems probable, however, that selection in this direction will cause a reversion of the form to the red type, as red is the normal color of the species.

5. *Varieties.* It has not been deemed advisable to grow a large number of varieties; but rather, to select the best of the older, well known sorts, and such new ones as may appear from time to time. Earliness is one of the principal measures of value for any variety in this climate, and many valuable sorts must be discarded because they are not early. I am aware that some contend that there is practically no difference in earliness, but the fact remains, and we must shape our course accordingly. Owing to the unusually long season, all varieties ripened some fruit during the past year.

Beauty. (Livingston).—Of medium size, bright pink, smooth, uniform, prolific. A well tried and valuable sort.

Chemin Market. (Cornell University, Vaughan).—Small to medium, bright red, smooth, prolific; uniform in size and shape, somewhat resembling Hathaway. Possibly too late, but worthy of further trial.

Cleveland. (*President Cleveland*, Farquhar).—Small, red, corrugated about the base. Plant vigorous, but only moderately productive.

Favorite. (Livingston).—Of good size, bright red, smooth. As usually grown, a deservedly popular variety. The strain grown this year was not equal to that grown before, however.

Faultless. (*Faultless Earty*, Farquhar).—Small, early, bright red, flattened or indented at apex. Early fruits very irregular; later ones better. Plant of medium size, productive, matures early.

Golden Queen. (Cornell University, Livingston).—Of medium size, spherical, smooth, clear golden yellow with occasionally a blush cheek; early, prolific. The best yellow tomato, and a valuable sort for the home garden.

Ignotum. (Cornell University).—Large, smooth, deep red, firm and meaty, with few seeds; early and productive. This variety originated at the Michigan Agricultural College, and has been on

the market only two or three years. From well selected stock it easily ranks at the head of the red tomatoes.

Ithaca. (Cornell University).—Small to medium, light cherry, firm, smooth, of good quality, but appears to possess no characteristics which render it more valuable for field culture than some of the older varieties. The variety is a local one grown by gardeners in the vicinity of Ithaca, N. Y., for many years. It is not yet catalogued by any of the seedsmen. We have the variety growing in the house at the present time, and are very much pleased with it as a forcing variety.

Long Keeper. (Thorburn).—Of medium size, light purple, smooth, symmetrical, ripens evenly without tendency to rot. Promising.

Lorillard. (Cornell University).—Of medium size, nearly spherical, bright red, smooth, fairly productive. The special value of this variety is as a forcing tomato. For this purpose it is one of the best.

Mitchell. (Gregory).—Small to medium, inclined to be irregular, bright red. A rampant grower.

Peach. (Thorburn).—Small, purple, very prolific; soft but keeps well. Unlike any other tomato, this variety has a rough skin and when just maturing the resemblance to a peach is quite noticable. Valuable for amateurs.

Potomac. (Harris).—Of the Acme type; large, purple, corrugated about the stem, soft.

Prelude. (Thorburn).—Small, nearly spherical, smooth, uniform, early, very prolific. Valuable for the amateur.

Red Cross. (Farquhar).—Of medium size, smooth, bright red.

Ruby. (Henderson).—Small, red, inclined to be angular. Plant of weak habit. Not as satisfactory as in 1890.

Stone. (Livingston).—Medium to large, smooth, regular, bright scarlet, productive. Promising.

The varieties which appear to us most valuable for general culture are, Ignotum, Perfection, Beauty and Golden Queen, with the possible addition of Prelude for the home garden.

Of the newer varieties, Long Keeper and Stone are promising. Ruby does not hold its own. Ithaca is a promising variety for forcing.

Summary.

1. An important requisite to successful tomato culture is that the plants be kept growing vigorously; a condition involving rich soil and frequent tillage.

2. Frequent transplanting makes stocky plants.

3. Plants are not checked as much as is commonly supposed, by the cool nights of early spring.

4. Other things being equal, the earliness and productiveness of tomatoes is in direct proportion to the earliness of setting in the field.

5. Trimming the plants after a part of the fruit had set, increased the yield by more than one-third.

6. The best varieties for general use appear to be Ignotum, Perfection, Beauty, Golden Queen, and possibly Prelude for home use.

7. Of the new varieties, Long Keeper and Stone are most promising.

III. Notes of Egg Plants.

As already noted, we are making the egg plant a subject of special study. A full report in regard to this work is reserved till a later date, however.

Egg plants delight in a warm, moist climate, rich but light soil, and constant cultivation. While they reach the highest state of perfection in warmer climates, and near the coast, by careful treatment they may be grown over a large extent of country. In this climate they should be started as early as the first of April, in a hot bed or forcing-house, and should be kept growing vigorously till about the middle of June, when they may be removed to the open field. They should be placed in rows about three feet apart to permit the use of a horse in cultivating.

Frequent and thorough cultivation is a prime requisite to success. We make a practice of going through the plantation at least once a week with a Planet Jr. cultivator, and make free use of the hoe as well.

Of the varieties commonly catalogued, *Early Long Purple* and *Early Dwarf Purple* will doubtless prove most satisfactory in this climate. The larger and later sorts will hardly begin to develop fruit before the early frosts. There is reason to believe, however, that valuable results may be obtained by crossing these

early, prolific varieties with some of the larger sorts. From crosses we now have growing, more satisfactory results were obtained during the past season, than from any of the older fixed varieties.

FRUIT TESTS.

The Experiment Station is not situated within the section of the state best adapted to fruit culture. Being on the flat bottom lands in the valley of the Penobscot, conditions of soil and climate are different, and somewhat more trying than in other portions of the state. This fact has its advantage, however, as varieties which prove hardy at Orono will probably succeed in any of the southern counties of the state.

The scope of the work already in progress has been indicated in a general way in the annual reports of the Experiment Station for 1889 and 1890. At the beginning of the present year, when the orchard came under the care of the writer, the trees were in a very bad condition from the effects of the severe winter.

The winter of 1890-1 was one of the coldest known for twenty years; the mercury on one occasion reaching —36.3°, while the mean temperature for December was 12.2° Fahr. The fruit plantation is on warm, rich soil, and the trees failed to mature the new growth. Consequently, trees which should prove hardy in our climate were either killed or severely checked. The loss was specially marked in case of pears and plums.

An all important requisite of hardiness is that the wood complete its growth early in the season, and become well matured before cold weather approaches. Hardiness is therefore only relative, and may in a measure be controlled by the cultivator. Orchards and fruit plantations generally, should not be cultivated after the first of August, till growth is checked by heavy frost.

The following field notes indicate in a general way the condition of the orchard at the beginning of the year, and the relative hardiness of different varieties:

Pears

Angoulême.....Killed.
Anjou.....Considerably injured.
Bartlett.....Top killed. Sprouts above graft.
Clairgeau.....One killed outright. The others, top killed, but sprouts appear.
Clapp's Favorite.....In good condition.
Flemish Beauty..... " " "

Hardy.....One killed, the other injured.
Howell.....Slightly checked. Starts well.
Josephine de Malines.....One killed to the roots; the others badly injured.
Keiffer.....Killed.
Lawrence.....Slightly injured.
Le Conte.....Killed.
Louise Bonne.....Top killed. Sprouts above graft.
Seckel.....Killed.
Sheldon.....In good condition.
Souv. du Congres.....One killed; the others badly injured.
Superfine.....Considerably injured.
Winter Nellis.....Slightly checked; starts well.

PLUMS.

Blue Damson.....One killed outright. The others top killed.
Bradshaw.....Uninjured; not vigorous.
Duane Purple.....Uninjured.
Gen. Hand.....All but one dead; this, badly checked, but starts well.
German Prune.....Uninjured.
Golden Drop, (Coe's).....Checked, but starts vigorously.
Imperial Gage.....All but one killed; this badly injured.
Jefferson.....One killed, the others badly checked.
Lombard.....Very badly injured. Had made remarkably strong growth the previous season.
Moore's Arctic.....Uninjured.
Pond's Seedling.....One killed, the other badly checked.
Quackenbos.....Uninjured.
Reine Claude.....One killed; the others badly injured.
Simons' (Prunus Simoni.) ..... " " " " "
Smith's Orleans..... " " " " "
Washington..... " " " slightly "
Weaver.....Badly checked, but starts vigorously.
Wild Goose.....Killed.
Yellow Egg.....Uninjured.

CHERRIES.

Of the eight varieties of cherries, but one, Gov. Wood, was seriously checked, and this one made a good growth during the past season. Part of the varieties were protected, however, by means of a cedar hedge on the northwest.

The data are interesting, as showing the condition of the experimental orchard after the first hard winter, and as exhibiting unexpected variations in hardiness. Of the pears, those least

injured by the winter were: Clapp's Favorite, Flemish Beauty, Howell, Lawrence, Sheldon, and Winter Nellis. Of plums, the most hardy appear to be: Bradshaw, Duane Purple, German Prune, Moore's Arctic, Quackenbos, Washington, and Yellow Egg. The injury to Lombard, one of our hardiest varieties, is in accordance with the statement before made, that hardiness is only a relative condition. This variety, because of its vigorous, watery growth, failed to mature the wood and suffered accordingly.

During the past year the orchard has been largely extended and the trees have made a vigorous growth. Several of the newer varieties of apples and pears, as well as some older ones not common in this region, have been added to the collection. Several varieties of plums, cherries and quinces have also been added.

Small fruits are also receiving due attention. The climate of the state is such that cultivators may take advantage of the natural conditions of the markets, and with suitable varieties, make the culture of small fruits a very profitable industry. The fruit may be put upon the market at a season when there is little competition from other sources, and when the best fruit will command high prices. We are endeavoring to determine the best of the hardy varieties now before the public, and to secure by means of selection and crossing, new varieties specially adapted to the climate, and to the demands of the natural markets of the state.

During the year, the following varieties have been added to the collection of small fruits. (The list of varieties before planted was published in the annual reports for 1889 and 1890.)

Blackberries: Agawam, Ancient Briton, Early Cluster, Stone (Stone's Hardy).

Raspberries: Hansell, Marlboro, Turner, Tyler, Johnston (Johnston's Sweet).

Currant: Prince Albert, La Versaillais.

Gooseberries: Whitesmith, Downing.

No part of the state is better adapted for the general operations of agriculture than is Aroostook County. The winters are so severe, however, that fruit culture has heretofore received little attention. Until the advent of the Duchess and the Wealthy, all attempts at apple culture resulted in disappointment. It is but few years since the positive assertion was made, that fruit culture is impossible north of the latitude of Houlton, (46° 10').



PLATE III. GROWING TOMATOES UNDER GLASS.

By steady perseverance on the part of a few enterprising planters, however, there are now thriving orchards in the latitude of Presque Isle and Caribou, and even as far north as Fort Kent, on the extreme northern boundary of the state.

The range of varieties is very limited in this northern region, however; the standard of hardiness being the Duchess and the Wealthy. Some valuable seedlings of these varieties have been produced and the number is gradually being increased. Dudley's Winter, a seedling of Duchess, is of much promise and is being extensively propagated. The variety originated with Mr. J. W. Dudley of Castle Hill Plantation.

In the hope of extending the list of apples and other fruits which may be grown in the more rigorous portions of the state, arrangements have been made with Mr. James Nutting of Perham, who has perhaps the largest orchard in northern Aroostook, to test certain varieties sent him and report to this department from time to time.

In April of the present year, cions of the following varieties of apples were sent to Mr. Nutting: Severs, Iowa Blush, McMahon, and Harry Kaump, from the U. S. Department of Agriculture.

Peach of Montreal, Prolific Sweeting, Longfield, Titus, Bethel of Vermont, Yellow Transparent, and Shiawassee Beauty, from Dr. T. H. Hoskins of Newport, Vermont.

"Sally" and Sweet Seedling, two seedlings of promise, from D. H. Knowlton, of Farmington, Me.

A few cions of Shiawassee Beauty were also sent from the college orchard for comparison with those from northern Vermont.

In addition to the apples, cions of the Hawkeye plum were sent, and grafted in the native Canada plum, *(Prunus Americana)*. Part of the apple cions were set in bearing trees, Duchess, and part in Duchess seedlings, one year stock.

The following is Mr. Nutting's report concerning the first year's growth:

Cions set in bearing trees: The trees are about twelve years old and being set 12x12 feet, are somewhat crowded. The cions, except those from Vermont, and the seedlings, were not in good condition, growth having commenced in most instances.

GROWTH OF CIONS IN BEARING TREES.

Variety.	Where obtained.	Number cions set.	Number cions living.	Average growth in inches.	Date of setting.
Harry Kaump	Dept. of Ag.	4	3	6	May 14.
Iowa Blush	" "	6	6	8	"
McMahon	" "	4	2	5	"
Severs	" "	6	3	5	"
Sally	Knowlton.	5	5	5	"
Sweet Seedling	"	2	2	20	"
Bethel of Vermont	Hoskins.	6	6	11	"
Longfield	"	6	5	6	"
Prolific Sweeting	"	6	6	6	"
Titus	"	4	2	18	"
Shiawassee Beauty	"	6	5	12	"
Shiawassee Beauty	College.	5	3	11	"

Cions set on seedling stock: Saddle or splice grafts were made on one year seedling stocks, and they were planted out the same day.

Variety.	Where obtained.	Number cions set.	Number cions living.	Average growth in inches.	Date of setting.
Iowa Blush	Dept. of Ag.	8	3	14	May 16.
McMahon	" "	3	0		"
Severs	" "	6	1	12	"
Bethel of Vt	Hoskins.	6	6	24	"
Longfield	"	2	2	12	"
Prolific Sweeting	"	5	5	12	"
Shiawassee B	"	7	3	14	"
Titus	"	4	4	12	"
Sally	Knowlton.	5	3	18	"
Sweet Seedling	"	2	1	20	"

The season was very dry and bad for nursery stock. All of the young trees were taken up November 12, and healed in for the winter.

The above report is given, not as indicating valuable results obtained, but as showing in a general way the work commenced in the "cold northeast." The deep snows constitute a serious obstacle to successful nursery culture during the first year or so. It is for this reason that the trees were taken up the first winter.

During the coming year the list of varieties under trial will be

materially increased, and the culture of certain small fruits undertaken. The conditions of soil and climate seem specially adapted to the growth of currants and gooseberries. The only plum which has as yet proved satisfactory in northern Aroostook, is Moore's Arctic, which originated at Ashland in that section. Even this variety requires laying down each fall.

The native "Canada plum," *Prunus Americana*, is very variable in its character, and the region in question is specially rich in promising types of this species. Several selections of the more promising forms have been made, and it is hoped by careful selection and culture, valuable "iron-clad" varieties may be obtained.

Trees and cions of Rollingstone and Hawkeye plums were procured last spring, and others of the hardy native varieties from the northwest, as well as some of the better Russian sorts, will be introduced next season.

EXPERIMENTS IN SPRAYING.

The great and increasing importance of the fruit interests of the state seem to demand special attention on the part of the Experiment Station, and as the depredations of the insect and fungous enemies of the orchard are becoming more and more severe year by year, it has been decided best to do all in our power to combat these pests.

In other states it has been shown, apparently beyond question, that at least some of these orchard pests may easily be held in check. While it is not to be supposed that conditions of soil or climate would render the work of other experiment stations of no value in Maine, it has been thought best to prove for ourselves, and to the satisfaction of the people of the state, the effectiveness of certain remedies, if they are effective. In the reports of this Station for 1889 and 1890, Professor Harvey urged the use of certain insecticides and fungicides and gave full directions for applying, with descriptions and cuts of various kinds of spraying apparatus. Heretofore, however, no field work has been undertaken by the Experiment Station. By mutual understanding this work has been placed in the hands of the writer.

Owing to the fact that the orchard belonging to the Experiment Station is not of bearing age, and that there are no large orchards in the vicinity of the college, the work has necessarily been at a

disadvantage. It was necessary to go to Kennebec county to find suitable orchards which were available. Much credit is due to the parties who have given the use of their orchards and have so faithfully assisted in the work. Special credit is due Messrs. Charles S. Pope of Manchester, W. P. Atherton of Hallowell, C. E. Moore and F. M. Woodward of Winthrop. These gentlemen all gave their time freely, and their intelligent assistance is appreciated.

There were two main objects in the field work of the present season: *first*, to combat the codling moth; and *second* to prevent, if possible, the ravages of the apple scab.

I. Codling Moth, *(Carpocapsa pomonella)*.

For a number of years several prominent experimenters and many progressive orchardists, have advocated the use of the arsenites, Paris green or London purple, to hold this pest in check. The experiments of Cook, Goff, Gillette and others would seem to leave little doubt as to the value of this treatment. However, for our own satisfaction, and to bring the matter more forcibly before the people of the state, the following work was undertaken:

1. *Is Spraying with Paris Green an Effective Remedy?* The first question asked by an orchardist, regarding any remedy or preventive, is: Does it prove effective? To answer this question, trees were sprayed in the orchards of Messrs. W. P. Atherton, of Hallowell; Charles S. Pope, of Manchester, and C. E. Moore of Winthrop.

In Mr. Atherton's orchard, a row of Rhode Island Greenings, and a row of Hubbardston Nonesuch were selected for the trial. Four Greening trees were sprayed with Paris green in the proportion of 1 pound to 250 gallons of water; an equal number received 1 pound to 300 gallons; and three trees were left unsprayed as checks. Of the Hubbardstons, one tree was sprayed with the mixture of 1 pound to 250 gallons; two, in the proportion of 1 pound to 300 gallons, and two were left unsprayed.

Two applications were made. The first one, June 11, just as the last blossoms were falling, was under the personal supervision of the writer. The second was made by Mr. Atherton two weeks later. The weather was hot and dry at the time of each application.

The fruit was gathered October 3d. With the help at command it was found impracticable to pick and count the fruit from all of the trees. Therefore, in case of the Greenings, two trees of each lot were taken, reference being given to the relative size and productiveness of the trees, so far as possible. All of the fruit was picked from the trees, and all that had fallen was gathered separately.

Table IV indicates the comparative results.

TABLE IV—Rhode Island Greening.

Treatment.	Nature of fruit.	Whole number of fruits.	Number wormy.	Per ct. wormy.	Average per ct. wormy.
1 lb. to 250 gals.....	1st tree:				
	Picked	453	9		
	Fallen.....	67	18		
	TOTAL	520	57	10.96	
	2nd tree:				
	Picked	727	25		7.14
	Fallen	98	14		
	TOTAL	825	39	4.72	
1 lb. to 300 gals.....	1st tree:				
	Picked	1069	101		
	Fallen	165	53		
	TOTAL	1234	154	12 48	
	2nd tree:				
	Picked	1100	47		10.08
	Fallen	145	49		
	TOTAL	1245	96	7.71	
Not sprayed.....	1st tree:				
	Picked	1195	124		
	Fallen	228	114		
	TOTAL	1423	238	16.02	
	2nd tree:				
	Picked	556	73		20.11
	Fallen	253	138		
	TOTAL	809	211	26.08	

TABLE IV (Continued.)—HUBBARDSTON.

Treatment.	Nature of fruit.	Whole number of fruits.	Number wormy.	Per ct. wormy.	Average per ct. wormy.
1 lb. to 250 gals.....	Picked	773	13		
	Fallen	36	28		
	TOTAL.....	809	41	5.06	5.06
1 lb. to 300 gals.....	1st tree:				
	Picked	681	11		
	Fallen	33	22		
	TOTAL.....	714	33	4.62	
	2nd tree:				
	Picked	836	75		10.04
	Fallen	83	56		
	TOTAL.....	919	131	14.25	
Not sprayed.	Picked	652	145		
	Fallen	169	122		
	TOTAL.....	821	267	32.52	32.52

While none of the trees were as severely attacked as is the case some years, there was a marked difference between the sprayed and the unsprayed trees. The unsprayed Greening trees had an average of about 20 per cent. of wormy fruit; while in no case was there more than 12.5 per cent. on the sprayed trees, and in most instances the percentage was much lower. With the Hubbardstons the difference was fully as marked; the percentage of wormy fruit on the unsprayed trees being 32.5, while the highest percentage from a sprayed tree, the weaker solution being used, was but 14.25

By observing column five in the table, it will be seen that the percentage of wormy fruits is much less when the stronger mixture was used. By the use of the weaker mixture, nearly one-half, (49.8 per cent.), of the loss was prevented, while by the use of the stronger mixture the amount of wormy fruit was reduced by 64.5 per cent. The figure gives a graphic representation of the relative amount of wormy fruit under the different treatments; letting *a* represent the average amount of wormy fruit on the trees sprayed with the stronger mixture; *b* the weaker mixture and *c* the unsprayed trees.



In addition to the work above detailed, several Greening trees in another orchard some distance from the first were sprayed with

Paris green in the proportion of 1 pound to 250 gallons water. Two applications were made as in the other orchard. In getting data from this orchard, three hundred fruits were taken indiscriminately from all parts of each tree. The percentage of wormy fruits thus obtained, while not absolutely final, may be regarded as a fair basis for comparison. The trees were in parallel rows, thirty feet apart.

The following figures indicate the comparative results:

	Sprayed.			Not Sprayed.		
	Number of fruits.	Number wormy.	Per cent. wormy.	Number of fruits.	Number wormy.	Per cent. wormy.
1st tree	300	44	**14.7**	200	74	**37.**
2nd tree	300	40	**13.3**	300	113	**37.7**
3d tree	300	20	**6.7**	300	85	**28.3**

As will be seen, more than one-third (34 per cent.), of the fruit on the unsprayed trees was wormy; while on the sprayed trees, only one-ninth (11.5 per cent.), was wormy.

In other words, spraying the trees twice with Paris green reduced the number of wormy fruits by 66.3 per cent. and saved more than one-fifth, (22.5 per cent.), of the total crop.

Results in Mr. Pope's Orchard.

In order that we might have as many checks on our work as possible, an arrangement was made with Mr. Charles S. Pope, of Manchester, to spray a portion of his orchard with Paris green. But one application was made, June 25, when the fruits were about the size of acorns.

The results obtained are given in table V.

TABLE V.

Variety and treatment.	Sprayed.				Not Sprayed.				Ratio of sprayed to unsprayed trees.	Remarks.
	Whole number of fruits.	Free.	Wormy.	Per cent. wormy.	Whole number of fruits.	Free.	Wormy.	Per cent. wormy.		
Talman (1 lb. to 320 gal.)	344	274	70	**20.3**	392	226	166	**42.3**	**1:2.07**	All fruits picked from trees and all from ground that had fallen in 2 w'ks.
	397	308	89	**22.4**	681	371	310	**45.5**		
Baldwin (1 lb. to 240 gal.)	451	403	48	**10.6**	431	338	93	**21.6**	**1: 1.61**	About 2½ bu. from all parts of each tree
	409	349	60	**14.6**	462	374	88	**19.0**		

The figures for each variety must be considered independently, as the trees were not in adjacent parts of the orchard. It will be

seen, however, that in both instances there is a marked difference in favor of the sprayed trees.

The percentage of wormy fruit on both sprayed and unsprayed trees was much greater in case of the Talmans than with the Baldwins. A study of the table will show, however, that the actual increase of the sprayed over the unsprayed trees, in the amount of good fruit, was even greater in the first case. The figures are of value as showing the beneficial effects of even a single application of a dilute mixture.

As indicated in the last column of the table the ratio between the sprayed and unsprayed Talman trees is 1 : 2.07. In other words, if in a barrel of fruit from the sprayed trees there were 100 wormy fruits, there would be 207 wormy fruits in a barrel from the unsprayed trees. In the same way for every 100 wormy fruits on the Baldwin trees which were sprayed, there would be 161 on the trees not sprayed.

2. *Relative Number of Windfalls on Sprayed and Unsprayed Trees.* Observing that the number of fallen fruits was much greater under the unsprayed trees, a record was kept showing the absolute difference.

In case of the Greenings (see Table IV) sprayed with 1 pound to 250 gallons, 1 pound to 300 gallons, and unsprayed, the average amounts were respectively, 12.5, 12.3, and 21.5 per cent. of the total crop. With the Hubbardstons the difference was even more marked, the percentages being respectively 4.45, 10.04, and 20.58.

The owner of the orchard not being ready to harvest his Baldwins, and it being impracticable for the writer to make another visit to this orchard, a count was made of the actual number of windfalls under sprayed and unsprayed Baldwin trees at that date, October 4. An examination of three trees each, as nearly alike as possible, gave the following as the *average* results.

	Whole number of fruits.	Number wormy.	Per cent. wormy.
Sprayed,	144	55	38.2
Not Sprayed,	268	222	82.8

The absolute number of windfalls in case of the unsprayed trees exceeded that from the sprayed trees by 53.7 per cent., while the relative number of wormy fruits was correspondingly large, the difference in the average being 44.6 per cent. The figures plainly indicate that the actual number of fallen fruits is less from trees

sprayed with Paris green, also that the percentage of wormy fruits among the windfalls is smaller from the sprayed trees.

3. *Negative Results.* Incidental to some other experiments, a few trees in an orchard belonging to F. M. Woodward, of Winthrop, were sprayed with Paris green. The work was conducted by Mr. C. E. Moore.

When spraying for the apple scab, certain trees were sprayed once with a mixture of Paris green and carbonate of copper in suspension. The poison was used in the proportion of 1 pound to 160 gallons of water. The trees were old, and were surrounded by unsprayed trees.

About three bushels of fruit were counted from each of four trees, care being taken to obtain fruit from all parts of the tree.

The results were as follows:

Sprayed.			Not Sprayed.		
Perfect.	Wormy.	Per cent. wormy.	Perfect.	Wormy.	Per cent. wormy.
387	93	19.3	480	75	13.5
218	86	28.2	394	159	28.5

The results are indifferent or negative. The conditions were such, however, that little reliance is placed on this test.

4. *Point of Attack.* The objection has been raised by some of our fruit growers that a large proportion of the affected fruit is entered from side or base, and consequently that spraying before the fruit turns down has no special merit. Special attention was accordingly directed to this point. The variety under consideration was Rhode Island Greening.

No. of tree.	Whole No. of wormy fruits.	Entrance at calyx.	Entrance at side or base.	Ratio.	Remarks.
1	57	24	33	1:1.37	Sprayed twice,—1 lb. to 250 gallons.
2	39	14	25	1:1.78	" " " " "
3	96	32	64	1:2.00	Sprayed twice,—1 lb. to 300 gallons.
4	154	63	91	1:1.44	" " " " "
5	238	141	97	1:0.69	Not sprayed.
6	211	111	100	1:0.91	" "

It will be observed that while the absolute number of wormy fruits is greatly in excess, in case of the unsprayed trees, the relative number of entrances at the calyx is more than doubled. The most plausible explanation for this condition would seem to

be that the poison lodging in the calyx, had destroyed the larvæ attempting to enter that end, while those entering the side or base escaped. The larvæ of the second brood were also exempt.

It was observed that a large proportion of the fruits infested, had been attacked by the second brood, and the larvæ were still present. To spray for this later brood is hardly practicable, but if the earlier brood is held in check, there will be less trouble from the later.

In many cases the casual observer would attribute injury to the codling moth, when in reality it is due to another insect—a species of *crambus*. The larva of this moth is smaller than that of the codling moth, and works only in the calyx. This insect was quite abundant the past season and rendered the work of examination for the codling larvæ more difficult.

5. *Is Sprayed Fruit Unwholesome?* The objection is frequently raised that fruit which has been sprayed is unsafe for food; that enough poison will adhere to render the fruit dangerous to health. The matter has attracted some attention in England recently, and there has been an outcry against American apples. One writer in the *Horticultural Times* of London, is quoted as saying: "If the American apple as it comes from the vessel is carefully rubbed with the finger, it will be seen that a fine, delicate powder is in most cases removed. This is the arsenic adhering to the skin." (!)

There certainly is no doubt that fruit from which a coating of arsenic may be rubbed, would be very unwholesome. The objection is not valid, however, as the fine, white powder *is not Paris green*. A large part of the fruit sent from this state is shipped in empty flour barrels; a fact which doubtless accounts for the fine, delicate powder on the fruit referred to. I have yet to see the fruit which at maturity showed any visible effects of spraying, unless it were comparative freedom from worminess.

The charge as to the unwholesome character of sprayed fruit has frequently been refuted, and it is only necessary to call attention to the amount applied, to render further argument unnecessary. The strongest mixture recommended is 1 pound to 200 gallons water. (If carefully applied there is little doubt that 1 pound to 250 gallons is strong enough.) If we apply two gallons of the mixture to a single tree, we should use approximately 1-100 of a pound, or 70 grains of the poison on the whole tree at each application. The fruits are so small at the time of spraying that

it would be impossible to make so much as 5 per cent. of the poison stay on them. There is not sufficient surface to retain a larger amount. Supposing this proportion correct, however, and that the trees are sprayed twice, if there are 1,200 fruits—about three barrels—to the tree, the amount of poison per fruit would be less that 3-1000 (.0029) grain.

In our calculations we have not taken into account the fact that the fruit is exposed to sunshine and rain for four months before it is ready for use. On considering all phases of the question we are led to the conclusion that there is no reason why fruit sprayed as directed should be unwholesome when mature.

6. *When to Spray.* In planning the work for the season, it was designed to learn, if possible, the best time to spray, as well as the amount of poison necessary. Owing to pressure of other work, however, the instructions left by the writer were not fully carried out.

The time when the first brood commences depredations, is not fully determined by entomologists; but it certainly extends over a considerable period and varies with the season. Professor Gillette has shown that in some seasons, at least, and with certain varieties, the larvæ may not hatch in considerable numbers for at least a month after the blossoms fall.* It would seem unnecessary, in such cases, to spray at once. With many varieties, however, the calyx closes soon after the blossoms fall, and later applications of the poison will necessarily be more or less ineffectual.

No doubt the fact that experimenters use different varieties, causes much of the difference in opinion as to the proper time to spray, and the value of the later applications. In case of the Duchess, the spray will be just as effective a month after the blossoms fall as at an earlier date. Hence, if the larvæ do not appear earlier, a single application at the later date will be just as effectual as two or more applications, part of which are made as soon as the fruit sets. With the Baldwin, however, the conditions are different. About two weeks after the blossoms fall, the lobes of the calyx close, and while the eggs may have been deposited, the poison applied as a spray is shut out.

It will be seen that it is unsafe to generalize from the results obtained with either class of apples. It is hoped in our work of next season we shall be able to secure valuable data on this point.

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* Bulletin 7, Iowa Experiment Station, 277.

In general it is safe to say the proper time for the first application is just after the fruit has formed; and for the second, some two or three weeks later. In no case should any spraying be done while the trees are in blossom. It is too early to be of any value whatever in checking the work of the codling larvæ, and very serious damage may be done in poisoning the bees, which are very abundant at that season.

7. *Work in Other States.* As early as 1880, Professor A. J. Cook, of the Michigan Agricultural College, commenced the use of the arsenites in combatting the codling moth and other orchard pests. He has been an earnest advocate of spraying ever since, and has done much to bring the practise into popular favor in the West.

Professor E. S. Goff in 1884, conducted a series of experiments at the New York Agricultural Experiment Station, in which he found that 69 per cent. of injury was prevented by the use of Paris green. Similar results were obtained by Dr. S. A. Forbes, of Illinois, in 1885.

In 1889, Professor C. P. Gillette sprayed four Duchess trees with London purple, taking four contiguous trees as checks. "At the end of the season it was found that the treated trees had 68 per cent. less of wormy fruit than those not treated."*

Professor Gillette also tried a new method of applying poison to the trees. His method was the same as that used by many farmers in treating potato vines for the Colorado beetle, *i. e.* mix 1 pound Paris green with 100 pounds land plaster and throw the mixture over the trees when the dew is on. This method is of course impracticable for use in a large orchard, and is suggested only as a possible expedient for saving the fruit on a few trees about the house.

Professor Beckwith (Bul. XII, Del. Exp. Sta.) found that: "The percentage of wormy fruit from trees sprayed with either London purple or Paris green was from 18 to 35 per cent. less than from trees not sprayed. The greatest benefit was obtained when the trees were sprayed three times, using the mixture at the rate of 1 pound to 200 gallons of water."

These results are at variance with those obtained by Gillette, who found that: "There was practically no difference between once and twice spraying;" and "No. 7, which was treated late,

* Bulletin 7, Iowa Experiment Station.

was about as well protected as any."* It is probable that this disagreement is due, as before suggested, to the character of the varieties used in the trial.

From the experiments of Cook† and Bailey‡ the conclusion is reached that Paris green is much less liable to injure the foliage than is London purple. London purple is exceedingly variable in composition, and frequently contains large amounts of soluble arsenic—in some cases as much as 40 per cent. The presence of soluble arsenic is specially dangerous to foliage.

Summary.

1. All sprayed trees had a smaller percentage of wormy fruit than did the unsprayed.
2. A mixture of one pound Paris green in 250 gallons water gave better results than did a weaker mixture; but
3. A mixture of 1 pound to 320 gallons, applied once, saved a large percentage of the fruit.
4. The number of windfalls was greatly lessened by spraying.
5. The proportion of wormy fruit among the windfalls was much smaller from the sprayed trees.
6. A large proportion of the wormy fruits from sprayed trees is entered from the side or base, while in fruits from unsprayed trees, the entrances at the calyx are largely in excess.
7. There is no danger from the use of fruit which has been sprayed as directed.
8. The best time to spray probably varies with different varieties, but in no case should any trees be sprayed before the blossoms fall.
9. The difference in the opinions of experimenters as to the proper time for spraying, is probably due to well known characteristics of different varieties.
10. There is greater liability to injury of foliage from the use of London purple than from the use of Paris green.

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* Bulletin 7, Iowa Experiment Station.

† Bulletin 53, Michigan Experiment Station.

‡ Bulletin 18, Cornell University Experiment Station.

II, Apple Scab, (*Fusicladium dendriticum.*)

It is not within the province of the writer to discuss in detail the characteristics of fungi injurious to fruits; but as no description of the disease known as *apple scab* has heretofore been published in the reports of the Experiment Station, it may be well to call attention, in a general way, to the nature of this disease.

All are familiar with the dark colored spots or scabs which appear on some varieties of apples,—notably the Fameuse, the Maiden Blush, and the Baldwin. These spots represent but one stage in the life history of a plant which grows on, and obtains its nourishment from the apple. In other words, apple scab is caused by the attack of a parisitic fungus—*Fusicladium dendriticum.* Its attack is not always confined to the fruit, and it is sometimes the cause of very serious loss to the orchardist.

The plant is reproduced by means of *spores*,* which are carried by the wind, and vegetate under favorable conditions. The most vigorous growth is made during cool, moist seasons. The climate of this state seems specially favorable for the growth of the fungus.



Fig. 1. A Diseased Apple.

Figure 1 represents the disease as it appears on the fruit. In badly affected specimens the scabby spots are much larger and often cause the apple to crack. The nourishment is all taken from the affected side, and in consequence the fruit is deformed. If the fruits are very young when attacked, they usually wither and fall.

The fungus attacks the leaves and young growing twigs as well as the fruit. If the attack occurs early in the season and is severe, much damage may

* The appearance of these spores is illustrated in the report of the Maine Experiment Station for 1889, page 182.

result. The vitality of the tree is lessened, and the effects are accumulative, thus reducing the possibilities of future crops.



Figure 2 Scab Spots on a Leaf.

The disease first appears on the leaves as brownish or olive-colored spots, as shown in figure 2. These spots, if numerous, run together and finally become blackish, and the leaf tissue dies. The effect on young foliage, attacked early in the season, is well shown in figure 3.* The cut is from a photograph taken in August and shows, on the left, a full sized leaf which developed after the first attack of the fungus. If the attack occurs later in the season, after the year's growth is nearly completed, but little injury is wrought.



Fig. 3. Blighted Foliage.

* The plates for figures 2 and 3, were loaned us by the Cornell University Experiment Station.

Results of Spraying.

For several seasons past, experiments have been conducted in various states for the purpose of determining a successful method of controlling the apple scab fungus. It has been found that in many instances much benefit is derived from the use of solutions of some of the compounds of copper.

During the past season a series of experiments was planned with the purpose in view of determining on an extended scale the effectiveness of certain mixtures, and some of the problems relative to methods of application. The latter and most extensive portion of the work was carried on in the orchard of F. M. Woodward of Winthrop, the work being conducted by Mr. C. E. Moore, under the direction of the writer. Owing to local conditions, most of the problems under consideration remain unsolved. Much credit is due Mr. Moore, however, for the faithfulness with which he attended to the spraying. The work will be continued next season.

The first part of the work, that of determining the effectiveness of certain compounds, was carried on in the orchards of Mr. Charles S. Pope, of Manchester, and the results were eminently satisfactory. Fifty-nine Baldwin trees were sprayed with various mixtures, and a suitable number was left to serve as checks. The trees were of medium size and bore from one and one-half to three barrels of fruit. The time at command when the fruit was gathered was so limited that all of the trees could not be examined critically; but a sufficient number was examined to give a fair basis for our conclusions.

In gathering the fruit, except where the whole was taken, about two and one-half bushels were taken at random from all parts of each tree, the plan being to get a fair average of the fruit. The baskets were filled from the lower limbs on all sides of the tree; then from the branches at the height of a man's head; then higher, and finally in the very top.

Four different solutions were used:

A.—A modified form of *eau celeste*.

B.—Ammoniacal solution of copper carbonate, using 3 ounces copper carbonate, 1 quart ammonia, and 30 gallons water.

C.—Same as B, except that but 2 ounces of copper carbonate was used.

D.—Copper carbonate in suspension—2 ounces copper carbonate in 25 gallons water.

The unsprayed trees were so distributed as to serve as checks for more than one solution.

The accompanying table gives a comprehensive view of the results obtained.

TABLE VII.—*Effects of Copper Solution on Apple Scab.*

Solution used.	Number fruits examined.	Free from scab.	Slightly scabby.	Badly scabbed.	Worthless.	Per cent. free.	Per cent. "No. 1" fruit (as regards scab).	Remarks.
A.								
	383	231	52	78	22	60.3	73.9	
	264	138	85	33	8	52.3	84 5	
	441	160	193	74	14	36 3	80.6	
	473	276	121	66	10	58 4	83.9	
	732	504	189	34	5	68.9	94.7	
Average per tree	**459**	**262**	**125**	**57**	**12**	**57.0**	**85.0**	
B.								
	972	318	524	120	10	32.7	86.7	
	780	463	262	48	7	59.4	92.9	
	541	278	226	37	0	51.4	93.1	
	918	471	345	94	8	51.3	88.9	
Average	**802**	**383**	**339**	**78**	**6**	**47.8**	**90.0**	
C.								About three-fourths of the fruits classed as slightly scabby were better fruits than those free from attack.
	936	271	506	149	10	28.9	83 0	
	734	200	391	129	14	27.3	80 5	
	490	239	196	50	5	48.8	88.9	
Average	**720**	**237**	**364**	**109**	**10**	**32.9**	**83.5**	
D.								
	669	15	148	329	177	2.2	24.4	Sprayed 3 times: May 22, June 15, July 28.
	484	18	146	233	87	3.7	33.9	
	653	42	147	299	165	6.4	28.9	Sprayed once, May 22.
	488	20	112	252	104	4.1	27.0	
Average	**576**	**24**	**138**	**278**	**133**	**4.1**	**28.1**	
CHECKS.								
	526	10	135	205	176	1.9	27.5	
	1046	23	156	508	359	2.2	17.1	
	615	58	179	283	95	9.4	38.5	
Average	**729**	**30**	**157**	**332**	**210**	**4.1**	**25.6**	

The table appears somewhat formidable, but the figures are significant. There was in every instance save one,—solution D,—a marked difference in the amount of scab on sprayed and unsprayed trees.

The highest per cent. of fruit free from scab was obtained from the use of the *eau celeste*, the gain being 52.9 per cent. or more than half the crop. The greatest actual gain, in the quantity of marketable fruit, however, was obtained from the use of the stronger solution of copper carbonate. The actual increase of

No. 1 fruit over the amount on unsprayed trees, in this case amounted to nearly 65 per cent. A closer comparison of the results with the different solutions is not made, because of a lack of uniformity in time of application.

The results obtained from the use of solution D—copper carbonate in suspension, will not warrant us in advising the use of that mixture. Our results from the use of this mixture are directly opposed to those obtained at some other experiment stations. At the Central Experiment Farm of Canada, Mr. Craig found the use of copper carbonate in suspension to make a difference of 26 per cent. in the number of fruits of the first quality, while the ammoniacal solution gave an increase of only 9 per cent.* In our work, as will be seen from the above table, there was *no* increase in the number of perfect fruits in the case of trees sprayed with solution "D," as opposed to an increase of **43.6** per cent. on trees sprayed with "B"—the ammoniacal solution. It will also be observed, that repeated applications of the mixture were of no value. The per cent. of fruit entirely free from scab, was actually higher on trees sprayed but once than on those sprayed three times.

The effect of the treatment with solutions A and B was even more marked in another of Mr. Pope's orchards. This orchard, which has been set about forty years, is located on a hillside with northwestern aspect. The orchard was used as a pasture for hogs, and the trees were growing vigorously.

Alternate rows were sprayed with solution A, the application being made May 11, before the buds opened, and June 19. The results were sufficiently marked so that it was possible to go into the middle of the orchard and determine which were the sprayed and which the unsprayed rows, from the general appearance of the trees.

Some of the trees in the check rows were sprayed May 22, and June 22 with solution B, the results being nearly as satisfactory as obtained with solution A. The fruit from four trees standing in immediate proximity to each other, was counted with the result shown in the table.

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* Cf. Bul. 10, Central Exp. Farm.

Treatment.	No. fruits examined.	Free from scab.	Slightly scabby.	Badly scabbed.	Worthless.	Per cent. free.	Per cent. No. 1 apples (as regards scab).	Remarks.
Solution A.	414	247	145	22	0	59.7	94 7	Sprayed twice,—May 11 and June 19.
Solution B.	461	133	232	91	5	28.9	79.2	Sprayed twice,—May 22 and June 22.
Check	474	35	191	219	29	7.4	47.6	Not sprayed.
Check	430	45	196	163	26	10.4	56.0	" "

It will be noticed that there is a decided difference between the unsprayed trees and the trees sprayed with either solution. The least difference, that between the best check tree and the tree sprayed with copper carbonate, was 18.5 per cent. of fruit absolutely free from scab, and 23.2 per cent. of fruit which would be classed as "No. 1."

It will also be observed, that in this instance the *eau celeste* gave better results than did the copper carbonate in an orchard where the efficiency of both might well be tried. Definite conclusions should not be drawn from results obtained with so few trees; but it may be seen that the results correspond very nearly to those in the first table. The per cent. of fruits absolutely free from scab is much larger on the tree sprayed with *eau celeste*, while those but slightly attacked preponderate on the other; thus bringing the percentage of salable fruits up well toward the first.

When it is considered that the cost of spraying a single tree is only about *three* cents for each application, the figures given above are very significant.

As before stated, most of the work in Mr. Moore's orchard, where methods of application and the merits of different solutions were under study, was of no value. A few trees in an old orchard near the house were sprayed in such a manner, however, that it is possible to get some idea of the relative value of spraying. The treatment was not continued during the season, as the trees were not included in the original plan of the experiment.

Two rows in an orchard perhaps forty years old, were sprayed on May 21, and June 12, with carbonate of copper in suspension—2 ounces to 30 gallons water—and Paris green, 1 pound to 250 gallons. In an adjacent row, the trees were sprayed once, June 15, with the ammoniacal solution—solution A. As seen in

Table VII, trees sprayed with copper carbonate in suspension were little better than unsprayed trees, and for comparison they may be regarded as checks.

The fruit from several trees was examined, with the following result:

	No. fruits examined.	Free from scab.	Slightly scabby.	Badly scabbed.	Worthless.	Per cent. free.	Per cent. No. 1 fruit.	
Copper carbonate in suspension, (check)....	492	3	123	257	108	.6	25.6	Average of three trees.
Ammoniacal solution of copper carbonate...	556	19	184	264	86	3.4	36.5	Average of two trees.

In another part of the same orchard two contiguous trees were examined with very similar results.

As will be seen at a glance, this orchard suffered very severely. Some trees were absolutely without a perfect fruit, and the average amount of fruit that would pass as No. 1, was but little more than one-fourth of the crop. The difference between sprayed and unsprayed trees is not very marked, but the figures point to the fact that there are uniformly beneficial results, even from limited applications.

An exception to the last statement may be noted in the case of a single tree in Mr. Pope's orchard. This tree was sprayed three times with *eau celeste*, the last application being made July 28. The amount of scabby fruit was slightly in excess of the average amount on unsprayed trees. The only explanation we can offer is that the leaves fell very badly, and the tree was less able to withstand the attack of the fungus late in the season. Any plant of weakened vitality is more subject to disease than is one of vigorous constitution.

How to Prepare the Mixtures.

Directions for preparing the modified *eau celeste*, and the ammoniacal solution of copper carbonate, as used at other experiment stations, were given in the report of this station for 1889. It may be well, however, to refer to the subject in the present connection.

Solution A.—Modified Eau Celeste.

Dissolve 2 pounds sulphate of copper, ("Blue stone"), in 2 gallons hot water. In another vessel dissolve 2 1-2 pounds carbonate of soda (sal soda); mix the two solutions, and, when

ready for use, add 1 1-2 pints strong ammonia water and dilute the whole to 28 gallons. The sulphate of copper should be dissolved in a *wooden* vessel as zinc or iron will corrode.

It is well to make the stock solution at least one day before it is wanted for use, and to mix a considerable quantity, merely observing the proportions suggested.

Solution B.—Ammoniacal Solution of Copper Carbonate.

The formula used in most of our work was as follows:

3 oz. copper carbonate.
1 qt. ammonia.
30 gal. water.

Dissolve the carbonate of copper in the ammonia and when ready for use add to the required amount of water. As with the *eau celeste*, the solution should be made several hours before desired for use.

The ammonia used in our work was nearly 26° Baumé (sp. grav. ——); and in some instances the foliage was injured. In the later applications the solution was diluted to 35 gallons, and it is probable that 40 gallons would be better.

It was found that only about 1 1-2 ounces of the copper carbonate would dissolve in one quart of ammonia; still better results were obtained from the use of the 3 ounces than from solution C, in which only 2 ounces copper was used in a quart of ammonia. Why this is so is not clear, since the simple copper carbonate in suspension appeared to have no value.

An improved formula for the ammonio-copper carbonate solution has been recommended. It is as follows:

3 oz. carbonate of copper.
1 lb. carbonate of ammonia.
50 gal. water.

Mix the carbonate of copper and the carbonate of ammonia thoroughly, and dissolve the mixture in two quarts of hot water. This solution may then be added to the full amount of water; or a considerable quantity may be prepared and used as a stock solution.

Solution D, copper carbonate in suspension, is not a true solution, as the copper carbonate is not soluble in water. It is made by adding a given amount of the copper salt to the water and, as in the case of Paris green, the particles are held in suspension

by continual agitation. This mixture is not recommended for general use.

Where to Procure the Chemicals.

The ingredients of the modified *eau celeste*, may all be obtained at any local drug store. If any considerable quantity is to be used, however, it is much cheaper to send to some reliable wholesale house and buy in bulk. For this reason it is well for farmers to club together in securing a supply of chemicals. Carbonate of copper is not usually handled by local dealers, and in ordering, it is well to specify that the *precipitated* form is desired.

The following firms are named as reliable parties who will supply the various materials at a reasonable cost:

Weeks & Potter Co., Washington street, Boston.

Eimer & Amend, 205 Third Avenue, New York.

W. S. Powell & Co., 202 Bowley's Wharf, Baltimore, Md.

Some dealers offer the ammoniated copper carbonate, "copperdine," ready for use by diluting with the proper amount of water. In this way less labor is required in preparation, but the ingredients are much more costly.

Summary.

1. Apple scab is caused by the attack of a parasitic plant—a fungus.

2. The fungus attacks the leaves and young twigs, as well as the fruit, and may seriously injure the tree.

3. The attack is most severe in cool, moist seasons.

4. Spraying with certain compounds of copper will hold the fungus in check.

5. In some cases the amount of No. 1 fruit on the sprayed trees exceeded that on unsprayed trees by 65 per cent. while the average increase of salable fruit was more than 50 per cent.

6. There appears to be little difference in effectiveness between the ammoniacal solution of copper carbonate, and modified eau celeste.

7. Three ounces copper carbonate dissolved in one quart ammonia gave better results than did a smaller proportion.

8. Carbonate of copper in suspension appears to be of no value as a fungicide.

9. The cost of spraying with eau celeste or the ammoniacal solution of copper carbonate, is about three cents per tree for each application.

III, Spraying Apparatus.

In the report of the Experiment Station for 1889, may be found figures and descriptions of several desirable force pumps and spraying nozzles. In addition to those there enumerated, we have used several others with which we are well pleased.



Fig. 4.
"Perfection" Spraying Outfit.

Figure 4 represents the "Perfection" outfit. This is the pump we have used in most of our field work. The pump is supplied with about ten feet of hose, and also has a second discharge pipe returning to the bottom of the barrel, thus keeping the mixture agitated. The cost of the pump with brass cylinder and plunger is $11.50. It is manufactured by the Field Force Pump Co., Lockport, N. Y. Other pumps of a similar style may be obtained of the Gould Manufacturing Co., Seneca Falls, N. Y., also of Rumsey & Co., of the same place.

In large orchards it is no small task to work the pump by hand and there is a demand on the part of owners of such orchards for a labor-saving device. To meet this demand, several styles of pumps with automatic gearing, have been constructed. One of these, the "Victor," made by the same company as the "Perfection" outfit, is shown in figure 5.

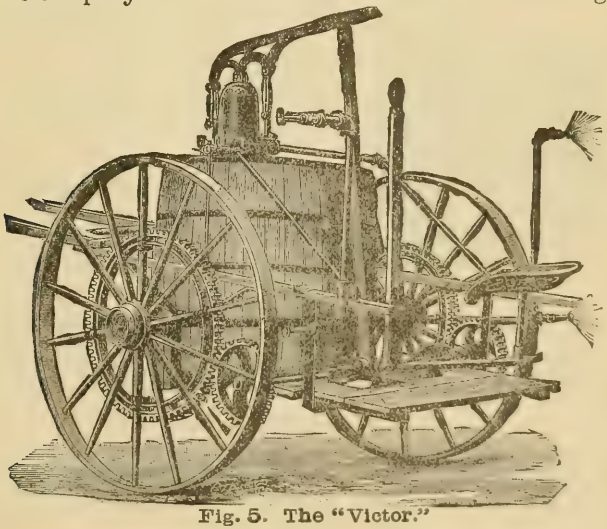


Fig. 5. The "Victor."

At a relatively small expense any of the hand pumps may be made to work automatically. Get a casting similar to that used on a hay tedder, with a small wheel to match, and with a bent crank-shaft the motion may readily be transmitted to the handle of the pump.

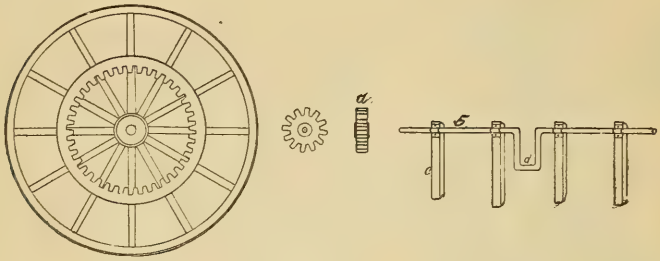


Fig. 6.

The accompanying sketch, figure 6, illustrates the method. The small wheel, *a*, works inside of the large cog-wheel. The crank shaft, *b*, is held firmly in place at the rear of the cart by the iron or wooden supports, *c*. The handle of the pump is connected with the crank shaft at *d* by means of a wooden rod. This method has been used to some extent, but I am not aware that it is patented.

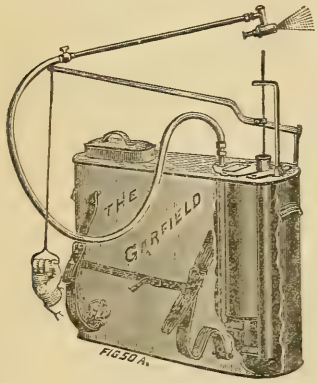


Fig. 7.

For shrubs, or low growing trees, one of the various knapsack sprayers will be found useful. Figure 7 represents the form made by the Field Force Pump Co., at a cost of $14.00. There are several other pumps not greatly unlike this, which sell at about the same price. The *Eureka*, manufactured by Adamson & Son, Washington, D. C., is an excellent pump, but is more expensive than the others, costing $21.00. The knapsack sprayers are specially valuable in the small fruit, and vegetable gardens, for spraying currant bushes or potato vines.

We have not succeeded in finding a nozzle more satisfactory for general purposes than the *Climax*, manufactured by the Nixon Nozzle & Machine Co., Dayton, Ohio. This nozzle is specially valuable in the application of Paris green, when fineness of spray is the great desideratum. It has been suggested

that a battery of these nozzles leading from a common chamber, would be an improvement over the present form. The aperture is so small in the form now in use, that too much time is lost in applying the liquid.

The "graduated spray" nozzle, which goes with the Perfection outfit, is good when accurately made, but if the central column is not quite true, the spray is uneven. This nozzle requires heavy pressure to give a satisfactory spray.

The knapsack sprayers are usually supplied with the vermorel nozzel, the form of which may be seen in figure 7.

GENERAL SUMMARY.

1. The work of the Horticultural Department during the past year has been largely in the way of organization.

2. The principal lines of investigation are in the study of the effects of climate on plant variation; effects of pollination; studies of the egg plant and the pepino; the amelioration of native fruits by selection and crossing; methods of culture of certain garden vegetables in the field and under glass; methods of combating orchard pests.

3. Experiments in the culture of cabbages show that the best results are obtained by frequent transplanting; that in general, depth of setting has little influence on the size of the heads; that disturbing the roots in transplanting has no marked effect on size of head or time of maturity.

4. Experiments with tomatoes show that frequent handling makes plants stocky; that early setting is advisable; that trimming the plants is an effective method of hastening maturity and increasing yield.

5. Egg plants may be successfully grown in this region by starting the plants early, and giving them rich soil and thorough cultivation.

6. The collection of fruits on the grounds of the experiment Station has been materially increased, but special attention is being given to developing varieties suited to the more trying localities of the state.

7. As a result of spraying apple trees with Paris green, it was found that all sprayed trees had less wormy fruit

than did the unsprayed trees; that the number of windfalls was greatly lessened by spraying; that the best time to spray probably varies with different varieties, but in no case should spraying be done before the blossoms fall. There is no danger from the use of fruit which has been sprayed as directed.

8. Spraying with the ammoniacal solution of copper carbonate, or with the modified *eau celeste*, is effective in checking the ravages of the apple scab fungus; but copper carbonate in suspension appears to have no value as a fungicide. The cost of spraying with *eau celeste* or with the ammoniacal solution of copper carbonate is about three cents per tree, for each application.

FERTILIZER EXPERIMENTS.

Prof. Walter Balentine.

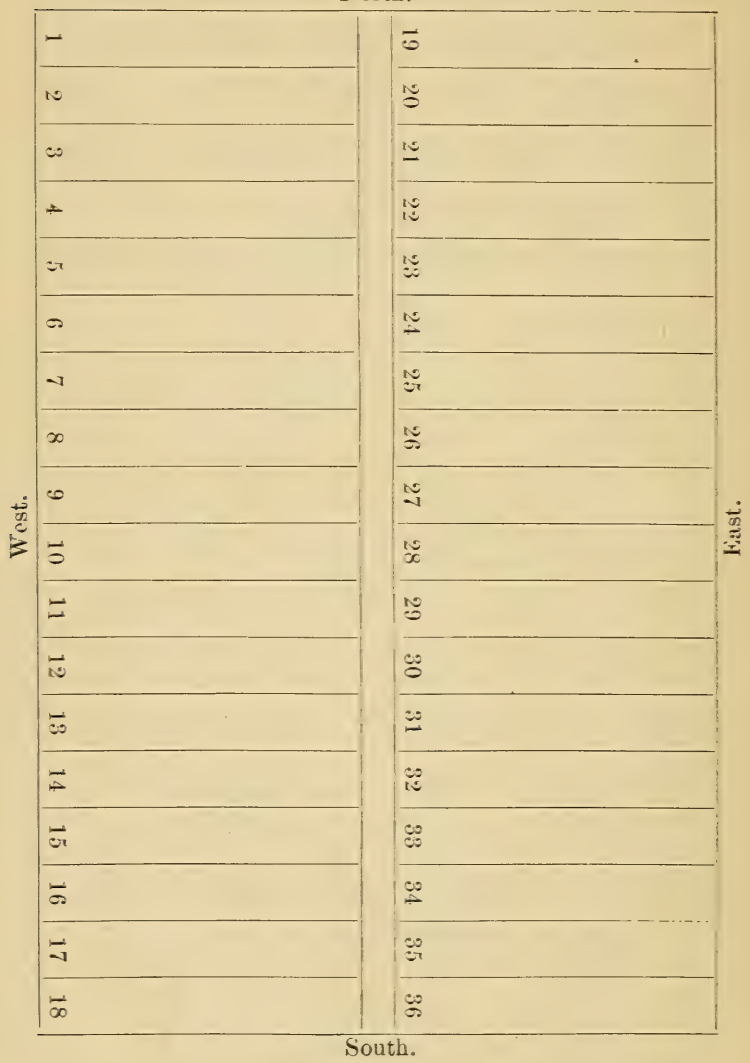
EFFECT OF DIFFERENT FORMS AND MIXTURES OF FERTILIZERS.

For the past six years the Station has been engaged continuously on the same land, with experiments, having for their object (1) The comparative effect of different forms of phosphoric acid in manuring crops; (2) A comparison between commercial fertilizers and stable manure in crop production; (3) The effect of a partial and complete fertilizer; (4) A comparison of the effect of different quantities of fertilizers.

The results of this work have been published from time to time in the Station Reports. Each year adds a little to the interest and value of the data obtained and the writer ventures to give, in connection with the report of the experiments of this year a review of those of preceding years.

The soil, or the field on which these experiments were carried out, was in condition to produce a fair crop of hay or grain, when the work was commenced. Thirty-six one-twentieth acre plots were laid off and numbered as indicated in the accompanying diagram of Experiment Field, No. 1.

DIAGRAM OF EXPERIMENTAL FIELD NO. 1.



In 1886, 1887 and 1889 the plots were treated as indicated in the following table, on each of the three years, so that the total amount of fertilizers applied during the six years that this field has been cultivated experimentally is three times the amounts given in the table, no fertilizer being applied in 1888, 1890 and 1891.

Plot 1, " 7, " 13	Received no fertilizer.
Plot 2, " 8, " 14	Dissolved bone black, 400 lbs. per acre. Muriate of potash, 100 " " " Sulphate of ammonia, 200 " " "
Plot 3, " 9, " 15	Fine ground bone, 360 lbs. per acre. Muriate of potash, 100 " " " Sulphate of ammonia, 140 " " "
Plot 4, " 10, " 16	Fine ground South Carolina rock, 300 lbs. per acre. Muriate of potash, 100 lbs. per acre. Sulphate of ammonia, 200 lbs. per acre.
Plot 5, " 11, " 17	Muriate of potash, 100 lbs. per acre. Sulphate of ammonia, 200 lbs. per acre.
Plot 6, " 12, " 18	Stable manure, 40,000 lbs. per acre.
Plot 19, " 25, " 31	Received no fertilizer.
Plot 20, " 26, " 32	Dissolved bone black, 400 lbs. per acre.
Plot 21, " 27, " 33	Dissolved bone black, 400 lbs. per acre. Muriate of potash, 100 " " "
Plot 22, " 28, " 34	Dissolved bone black, 200 lbs. per acre. Muriate of potash, 50 " " " Sulphate of ammonia, 60 " " "
Plot 23, " 29, " 35	Dissolved bone black. 300 lbs. per acre. Muriate of potash, 100 " " " Sulphate of ammonia, 120 " " "
Plot 24, " 30, " 36	Dissolved bone black, 400 lbs. per acre. Muriate of potash, 150 " " " Sulphate of ammonia, 180 " " "

In 1886 and 1887, the field was cropped with oats, in 1888 with grass. In 1889 the land was fallow. In 1890, a crop of peas was taken off and 1891 another crop of oats.

Comparative Effect of Different Forms of Phosphoric Acid.

Included in the tables showing the results of experimental work in this direction, are a set of plots that have been cultivated without manure, a set manured with stable manure from cows, and a set manured with muriate of potash and sulphate of ammonia. The three sets of plots which have been furnished phosphoric acid have been treated like the last named set with the addition of the phosphates.

Table A gives the yields per plot and the average yield per plot for the present year.

Table B shows the average yield per acre, the gains of the manured plots over the unmanured plots, and the gain per acre of the plots manured with phosphates, muriate of potash and sulphate of ammonia over those manured with muriate of potash and sulphate of ammonia alone.

Table C gives the yields for each year and the total yields of each crop.

TABLE A.

	No Manure.		Dissolved Bone Black 400 lbs., Muriate of Potash 100 lbs., and Sulphate of Ammonia 200 lbs. per acre, in 1886, 1887, and 1888.		Fine Ground Bone 300 lbs., Muriate of Potash 100 lbs., and Sulphate of Ammonia 140 lbs. per acre, in 1886, 1887, and 1889.		Fine Ground South Carolina Rock 300 lbs., Muriate of Potash 100 lbs., and Sulphate of Ammonia 200 lbs. per acre, in 1886, 1887, and 1889.		Muriate of Potash 100 lbs., and Sulphate of Ammonia 200 lbs. per acre, in 1886, 1887, and 1889.		Stable Manure 40,000 lbs. per acre in 1886, 1887, and 1889.	
	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
Plot 1	75.5 lbs.	59.5 lbs.										
" 7	50.0 "	25.0 "										
" 13	50.0 "	25.0 "										
" 2			73 0 lbs.	67.0 lbs.								
" 8			66.0 "	39.0 "								
" 14			63.0 "	42.0 "								
" 3					68.5 lbs.	71.5 lbs.						
" 9					67.3 "	32.7 "						
" 15					70.7 "	59.2 "						
" 4							58.5 lbs.	41.5 lbs.				
" 10							53.7 "	36.3 "				
" 16							61.5 "	38 5 "				
" 5									58.0 lbs.	47.0 lbs.		
" 11									59.5 "	20.5 "		
" 17									77.0 "	38.0 "		
" 6											75.3 lbs.	74.8 lbs.
" 12											87.0 "	58.0 "
" 18											71.0 "	129.0 "
Average	58.3 lbs.	36.3 lbs.	67.3 lbs.	49.3 lbs.	68.8 lbs.	54.5 lbs.	58.0 lbs.	38.8 lbs.	64.8 lbs.	35 2 lbs.	77.1 lbs.	87.3 lbs.

TABLE B.

	Fertilizers per acre for the years 1886, 1887, and 1889, in lbs.	Average yield per acre of oats, in bushels.	Average yield per acre of straw, in lbs.	Av'ge increase of grain of manured plots over unmanured plots per acre, in bushels.	Av'ge inc. of grain per acre in bu., of plots receiving phosphoric acid with potash & nitrogen, over those receiving only potash & nitrogen.
No manure		38.9	728		
Dissolved bone black	400				
Muriate of potash	100	44.9	986	6.0	1.7
Sulphate of ammonia	200				
Fine ground bone	3 0				
Muriate of potash	100	45.9	1090	7.0	2.7
Sulphate of ammonia	140				
Fine ground S. C. rock	3.0				
Muriate of potash	100	38.7	776	—0.2	—4.5
Sulphate of ammonia	200				
Muriate of potash	100	43.2	704	4.3	
Sulphate of ammonia	200				
Stable manure	40,000	51.4	1746	12.5	

TABLE C.

	No Manure.	Dissolved Bone-black 400 lbs., Muriate of Potash 100 lbs., and Sulphate of Ammonia 200 lbs. per acre, in 1886, 1887, and 1889.	Fine Ground Bone 300 lbs., Muriate of Potash 100 lbs., and Sulphate of Ammonia 140 lbs. per acre, in 1886, 1887, and 1889.	Fine Ground South Carolina Rock 300 lbs., Muriate of Potash 100 lbs., Sulphate of Ammonia 200 lbs. per acre, in 1886, 1887, and 1889.	Muriate of Potash 100 lbs., and Sulphate of Ammonia 200 lbs. per acre, in 1886, 1887, and 1889.	Stable Manure 40,000 lbs. per acre, in 1886, 1887, and 1889.
	Yield per acre.	Yield per acre.	Yield per acre.	Yield per acre.	Yield per acre.	Yield per acre.
Oats, 1886	55.7 bush. of 30 lbs.	82.9 bush. of 30 lbs.	76.2 bush. of 30 lbs.	72.2 bush. of 30 lbs.	64.5 bush. of 30 lbs.	73.9 bush. of 30 lbs.
Oats, 1887	26.7 " "	38.7 " "	31.9 " "	35.5 " "	35.1 " "	34.7 " "
Hay, 1888	2566 lbs.	2434 lbs.	2800 lbs.	2566 lbs.	2234 lbs.	4010 lbs.
Fallow, 1889						
Peas, 1890	12.3 bush. of 60 lbs.	15.0 bush. of 60 lbs.	15.7 bush. of 60 lbs.	14.3 bush. of 60 lbs.	12.7 bush. of 60 lbs.	22.7 bush. of 60 lbs.
Oats, 1891	38.9 " 30 lbs.	44.9 " 30 lbs.	45.9 " 30 lbs.	38 7 " 30 lbs.	43.2 " 30 lbs.	51.4 " 30 lbs.
Total crop in 6 years.						
Oats	121.3 bushels.	166.5 bushels.	154.0 bushels.	146.4 bushels.	142.8 bushels.	160.0 bushels.
Hay	2566 lbs.	2434 lbs.	2800 lbs.	2566 lbs.	2234 lbs.	4010 lbs.
Peas	12.3 bushels.	15.0 bushels.	15.7 bushels.	14.3 bushels.	12.7 bushels.	22.7 bushels.

An examination of table A shows that the set of plots which has been cultivated for six years without manure has yielded the present year 38.9 bushels of oats.

The following three sets of plots have each received during the six years three applications of what is called a complete fertilizer, that is, a fertilizer containing phosphoric acid, potash and nitrogen. The only difference in the treatment of the three sets of plots being that the source of phosphoric acid in the first set was dissolved bone black, in the second fine ground bone, and in the third fine ground South Carolina rock. This year's crop shows but little difference between the effectiveness of the phosphoric acid from dissolved bone black and fine ground bone. It should be remembered, however, that this crop was grown two years after the last application of the fertilizers and the soluble phosphoric acid of the dissolved bone black had, without doubt, reverted.

Little can be said in regard to the crop produced with South Carolina rock as a source of phosphoric acid. These plots gave a crop which was no greater than that obtained on the unmanured plots, and was less than was obtained on plots manured with muriate of potash and sulphate of ammonia with no South Carolina rock.

No explanation is known for this variation in the crop of the South Carolina rock plots, from what might have been expected.

The product on the plots manured with commercial fertilizers was unsatisfactory, considering the treatment they had received in the way of fertilizers.

Table C furnishes the data for studying the effect of the phosphoric acid from different sources through the six years since the experiment was commenced. Dissolved bone black gives the largest total yield of oats, the second largest yield of peas and the smallest yield of hay. Fine ground bone has given the largest yield of hay and peas and the second largest yield of oats. The South Carolina rock is second in yield of hay and third in yield of oats and peas.

The plots manured with commercial fertilizers gave large yields the first year of the experiment, two sets even exceeding the yield of the stable manure plots. The second year of the experiment the weather was unfavorable and the yield on all plots was light. The stable manure has, however, with the exception of that year, given uniformly good crops, while those upon which commercial fertilizers were used have not produced what could be called a

paying crop since the first year. The question naturally arises, why did we obtain so good results the first year with commercial fertilizer and such indifferent results in subsequent years. Many farmers who have tried to run a field with commercial fertilizers alone for a series of years have been confronted with the same facts that are encountered here.

The experiments do not furnish the data for a definite answer but attention is called to certain facts in connection with the history of this field. At the first plowing there was a heavy sod turned under which insured a first class mechanical condition of the soil for the crop that followed. Since that time, although grass has been produced on the field one season, no crop has been grown on sod as the ground was fallow the year following the grass crop. On the plots manured with stable manure large amounts of organic matter have been supplied in the manure which, on a stiff clay loam like the soil in the experiment, insures a better mechanical condition for the growth of crops.

SUMMARY.

(1.) On sod land all of the phosphates used in the experiment have been effective.

(2.) With oats, dissolved bone black has produced on the average the largest crop.

(3.) With peas and hay there has been but little difference in the effectiveness of the three phosphates used.

THE EFFECT OF A PARTIAL AND COMPLETE FERTILIZER.

The object of this experiment is to determine the needs of the soil of the College Farm and the special need of different crops on that soil.

The ordinary definition of a complete fertilizer is, one that furnishes all three of the elements which are most likely to be deficient in the soil, namely, potash, phosphoric acid and nitrogen.

A partial fertilizer is one from which one or two of the above named elements are omitted. It is in this sense that the terms partial and complete fertilizers are used.

Table D shows the quantity of oats produced the present year on unmanured plots, on plots manured with muriate of potash and sulphate of ammonia, on plots manured with dissolved bone black, on plots manured with dissolved bone black and muriate of potash, and two sets manured with complete fertilizers. Table E gives the average yields per acre of the same and the gains per acre of the manured plots over the unmanured plots. Table F gives the average yields for each year and the total yields of the different crops for the period of six years.

TABLE D.

	No Manure.		Muriate of Potash 100 lbs. and Sulphate of Ammonia 200 lbs. per acre in 1886, 1887, and 1889.		Dissolved Bone-black 400 lbs., per acre, in 1886, 1887, and 1889.		Dissolved Bone-black 400 lbs., Muriate of Potash 100 lbs. per acre, in 1886, 1887, and 1889.		Dissolved Bone-black 400 lbs., Muriate of Potash 100 lbs., and Sulphate of Ammonia 200 lbs. per acre, in 1886, 1887, and 1889.		Dissolved Bone-black, 400 lbs., Muriate of Potash 150 lbs., and Sulphate of Ammonia 189 lbs. per acre, in 1886, 1887, and 1889.	
	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
Plot 1	75.5 lbs.	59.5 lbs.										
" 7	50.0 "	25.0 "										
" 13	50.0 "	25.0 "										
" 19	69.0 "	61.0 "										
" 25	55.0 "	50.0 "										
" 31	54.8 "	20.3 "										
" 5			58.0 lbs.	47.0 lbs.								
" 11			59.5 "	20.5 "								
" 17			77.0 "	38.0 "								
" 20					62.0 lbs.	78.0 lbs.						
" 26					64.0 "	66.0 "						
" 32					62.5 "	67.5 "						
" 21							53.0 lbs.	67.0 lbs.				
" 27							60.0 "	65.0 "				
" 33							76.5 "	78.5 "				
" 2									73.0 lbs.	67.0 lbs.		
" 8									66.0 "	39.0 "		
" 14									63.0 "	42.0 "		
" 24											60.0 lbs.	70.0 lbs.
" 30											63.0 "	67.0 "
" 36											68.8 "	71.2 "
Average	57.0 lbs.	40.1 lbs.	61.5 lbs.	35.2 lbs.	62.8 lbs.	70.5 lbs.	63.2 lbs.	70.2 lbs.	67.3 lbs	69.3 lbs.	53.9 lbs.	69.4 lbs.

TABLE E.

	Fertilizers per acre in 1886, 1887, and 1889.	Yield of Oats per acre, in bushels.	Yield of Straw per acre, in lbs.	Increase of grain in bush., of manured plots over unmanured plots.
No manure		38.0	802	
Muriate of potash Sulphate of ammonia	100 lbs. 200 "	41.0	704	3.0
Dissolved bone-black	400 "	41.2	1410	3.2
Dissolved bone-black Muriate of potash	400 " 100 "	42.1	1404	4.1
Dissolved bone-black Muriate of potash Sulphate of ammonia	400 " 100 " 200 "	44.9	1346	6.9
Dissolved bone-black Muriate of potash Sulphate of ammonia	400 " 150 " 180 "	42.6	1388	4.6

TABLE F.

	Yield with no Manure.	Yield with Muriate of Potash 100 lbs. and Sulphate of Ammonia 200 lbs. per acre, in 1886, 1887, and 1889.	Yield with Dissolved Bone black 400 lbs. per acre, in 1886, 1887, and 1889.	Yield with Dissolved Bone-black 400 lbs. and Muriate of Potash 100 lbs. per acre, in 1886, 1887, and 1889.	Yield with Dissolved Bone-black 400 lbs., Muriate of Potash 100 lbs., and Sulphate of Ammonium 200 lbs. per acre, in 1886, 1887, and 1889.	Yield with Dissolved Bone-black 400 lbs., Muriate of Potash 150 lbs., and Sulphate of Ammonium 180 lbs. per acre, in 1886, 1887, and 1889.
Oats, 1886	54.1 bush. of 30 lbs.	64.5 bush. of 30 lbs.	55.2 bush. of 30 lbs.	54.3 bush. of 30 lbs.	82.9 bush. of 30 lbs.	68.0 bush. of 30 lbs.
Oats, 1887	27.4 " "	35.1 " "	28.1 " "	24.4 " "	38.7 " "	40.5 " "
Hay, 1888	2100 lbs.	2334 lbs.	2166 lbs.	2066 lbs.	2434 lbs.	2374 lbs.
Fallow, 1889						
Peas, 1890	12.5 bush. of 60 lbs.	12.7 bush. of 60 lbs.	14.2 bush. of 60 lbs.	15.0 bush. of 60 lbs.	15.1 bush. of 60 lbs.	15.9 bush. of 60 lbs.
Oats, 1891	38.0 " 30 lbs.	41.0 " 30 lbs.	41.2 " 30 lbs.	42.1 " 30 lbs.	44.9 " 30 lbs.	42.6 " 30 lbs.
Total crop in 6 yrs.						
Oats	119.5 bushels.	140.6 bushels.	124.5 bushels.	120.8 bushels.	166.5 bushels.	151.0 bushels.
Hay	2100 lbs.	2336 lbs.	2166 lbs.	2066 lbs.	2434 lbs.	2374 lbs.
Peas	12.5 bushels.	12.7 bushels.	14.2 bushels.	16.0 bushels.	15.1 bushels.	15.9 bushels.

Tables D and E show that all of the fertilizers have had an effect on the oat crop of the present year, and that the complete fertilizers have produced the largest yields.

An examination of the total crops of the entire period, as shown in Table F, reveals the fact that what has been found true of this year's oat crop is also true of the combined oat crop and hay crop, i. e. that the largest yields have been produced by complete fertilizers.

Examining the results furnished by the crop of peas, we find that muriate of potash and sulphate of ammonia produced practically no effect; that dissolved bone black alone caused an increase of nearly 13 per cent; and that dissolved bone black and muriate of potash caused an increase of 28 per cent. in the crop, which was not added to by the complete fertilizers. The results obtained from these experiments add weight to the prevailing idea that on an ordinary soil peas do not require nitrogenous manures.

SUMMARY.

The experiment brings out strongly the facts:

(1.) That for the soil on which it was conducted, phosphoric acid and nitrogen are of value as manures.

(2.) That phosphoric acid and potash are the most important fertilizing elements for peas.

THE COMPARATIVE EFFECT OF DIFFERENT AMOUNTS OF FERTILIZERS.

The object of this experiment is to study the limitations of the profitable use of commercial fertilizers. It must be remembered, however, that the work carried out on the college farm does not necessarily have a general application. But in view of the fact of the increasing use of commercial fertilizers, not only in this State but throughout the whole country, it is desirable to point out the existence of limitations, if there are any, that farmers may, in making their plans for carrying on their business, take them into consideration.

Tables G and H give the results of this year's cropping of the plots devoted to this purpose. Table I gives the results for the entire period together with the total value of crop, oats reckoned at 45 cents per bushel, hay at $10.00 per ton and peas at $1.25 per bushel. These values for the crop are liberal. The fertilizers have been reckoned at wholesale prices, dissolved bone

black at $24.00 per ton, muriate of potash at 2 cents per pound, and sulphate of ammonia at 3 cents per pound, which is lower than farmers usually pay for these material.

TABLE G.

	No Manure.		Dissolved Bone-black 200 lbs., Muriate of Potash 50 lbs., and Sulphate of Ammonia 60 lbs. per acre.		Dissolved Bone-black 300 lbs., Muriate of Potash 100 lbs., and Sulphate of Ammonia 120 lbs. per acre.		Dissolved Bone-black 400 lbs., Muriate of Potash 150 lbs., and Sulphate of Ammonia 180 lbs. per acre.	
	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Plot 1....	75.5	59.5						
" 7....	50.0	25.5						
" 13....	50.0	25.5						
" 19....	59.0	61.0						
" 25....	55.0	50.0						
" 31....	54.8	20 3						
" 22....			48.5	51.5				
" 28....			62.0	73.0				
" 34....			70.5	69.5				
" 23....					50.0	70.0		
" 29....					63.5	71.5		
" 35....					78.3	71.7		
" 24....							60.0	70.0
" 30....							63.0	67.0
" 36....							68.8	71.2
Average ..	57.0	40.1	60.1	64.7	63.9	71.1	63.9	69.4

TABLE H.

	Fertilizers per acre, in 1886, 1887, and 1889.	Yield of Oats per acre, in bushels.	Yield of Straw per acre, in pounds.	Increase of grain per acre, of manured plots over unmanured plots, in bu.
No manure		38.0	802	
Dissolved bone-black	200 lbs.			
Muriate of potash	50 "	40.1	1294	2.1
Sulphate of ammonia	60 "			
Dissolved bone-black	300 "			
Muriate of potash	100 "	42.6	1422	4.6
Sulphate of ammonia	120 "			
Dissolved bone-black	400 "			
Muriate of potash	150 "	42.6	1388	4.6
Sulphate of ammonia	180 "			

TABLE I.

Crop.	Yield without Manure.	Yield with Dissolved Bone-black 200 lbs., Muriate of Potash 50 lbs., and Sulphate of Ammonia 60 lbs. per acre, in 1886, 1887, and 1889.	Yield with Dissolved Bone-black 300 lbs., Muriate of Potash 100 lbs., and Sulphate of Ammonia 120 lbs. per acre, in 1886, 1887, and 1889.	Yield with Dissolved Bone-black 400 lbs., Muriate of Potash 150 lbs., and Sulphate of Ammonia 180 lbs. per acre, in 1886, 1887, and 1889.
Oats, 1886	54.1 bushels.	57.5 bushels.	69.0 bushels.	68.0 bushels.
Oats, 1887	27.4 "	30.0 "	28.6 "	40.5 "
Hay, 1888	2100 lbs.	2166 lbs.	1767 lbs.	2374 lbs.
Fallow, 1889				
Peas, 1890	12.7 bushels.	14.9 bushels.	13.7 bushels.	15.9 bushels.
Oats, 1891	38.0 "	40.1 "	42.6 "	42.6 "
Total value of crop	$80.14	$93.25	$89.04	$99.27
Value of crop on manured plots in excess of unmanured plots		$13.11	$8.90	$19.13
Value of fertilizers applied		$15.60	$27.60	$39.60

Table I furnishes the most important data. We find that the excess of the value of the crops on the manured plots over the unmanured plots is not sufficient to pay for the fertilizers in any case. We also find that the smallest amounts come nearer paying for themselves in the increase of the crop. It is probable, however, that the manured plots will continue to give larger yields on account of the applied fertilizers for some years to come. If the season of 1887 had been a favorable one for oats and an average crop produced, it is probable that those plots to which the least amount of fertilizer has been applied would have paid for the fertilizer in the increase of the crop. But it is not probable that either of the other sets of plots would have accomplished this result.

Conclusion.

From the investigation this conclusion can be safely drawn. Commercial fertilizers applied at the rate of 300 lbs. to 500 lbs. per acre are more likely to pay for themselves in increased crop produced than larger quantities.

Systems of Manuring.

The object of this experiment is, as was stated in last year's report, to compare a system of manuring with stable manure with systems of manuring with commercial fertilizers and with cropping without manure.

A ten acre field was selected and divided into plots of two and one-half acres each, as shown in accompanying diagram.

These plots were cropped two years with hay previous to the application of any manure in order to gain an idea of the relative fertility of the different plots at the beginning of the experiment. The average annual yield of hay was found to be as follows:

	Per Plot.	Per Acre.
Plot 1	6,355 lbs.	2,542 lbs.
" 2	6,040 "	2,416 "
" 3	5,207 "	2,082 "
" 4	6,265 "	2,510 "

Plot 4, which is under cultivation without manure, is taken as a standard from which to reckon the productiveness of the other plots had they been cultivated without fertilization.

The yield of this plot is taken as 100 per cent. The average annual yields of the other plots for the two years they were in hay as compared with this plot are

Plot 1	101 per cent.
" 2	96 "
" 3	80 "
" 4	100 "

In calculating what the probable yield of plots 1, 2 and 3 would be for any year, had no fertilizer been applied, the crop of plot 4 is taken for that year and multiplied by the per cent. of plot 4 which those plots produced while in hay before manuring.

Below is given a diagram of the field with amounts of fertilizers applied in 1890.

EXPERIMENTAL FIELD NO. 2.

North.

No. 1. 20 loads (6⅔ cords) Stable Manure per acre.	2½ Acres.
No. 2. 1000 lbs. South Carolina Rock, 66 lbs. nitrate of soda, 16 lbs. sulphate of ammonia, 100 lbs. muriate of potash per acre.	2½ Acres.
No. 3. 500 lbs. Acid South Carolina rock. 66 lbs. nitrate of soda, 16 lbs. sulphate of ammonia, 100 lbs. muriate of potash per acre.	2½ Acres.
No. 4. No Manure.	2½ Acres.

South.

Last year the north half of each plot was in peas and the south half in barley.

Table J shows the yields per one-half plot and per acre of the two crops which have been discussed in detail in the Station Report of 1890.

TABLE J.

Number of plot.	Yield of grain per ½ plot in 1890.	Yield of straw per ½ plot in 1890.	Yield of grain per acre in 1890.	Yield of straw per acre in 1890.
No. 1, N. half.	604 lbs. peas.	1406 lbs. pea straw.	483 lbs. peas.	1205 lbs. pea straw.
S. half.	552 lbs. barley.	2958 lbs. barley "	441 lbs. barley.	2366 lbs. barley "
No. 2, N. half.	453 lbs. peas.	758 lbs. pea straw.	362 lbs. peas.	607 lbs. pea straw.
S. half.	553 lbs. barley.	2527 lbs. barley "	404 lbs. barley.	2022 lbs. barley "
No. 3, N. half.	373 lbs. peas.	843 lbs. pea straw.	300 lbs. peas.	678 lbs. pea straw.
S. half.	542 lbs. barley.	1799 lbs. barley "	434 lbs. barley.	1439 lbs. barley "
No. 4, N. half.	417 lbs. peas.	848 lbs. pea straw.	334 lbs. peas.	678 lbs. pea straw.
S. half.	220 lbs. barley.	1310 lbs. barley "	156 lbs. barley.	1048 lbs. barley "

In the spring of the present year this field was seeded to oats and clover, with the object of getting a clover sod to determine its effect on the insoluble phosphoric acid of the South Carolina rock. A good catch of clover was obtained over the entire field. The result of the oat crop is shown in table K.

TABLE K.

Amount of fertilizers applied per acre in 1890.		Yield of oats per acre in 1891.		Calculated yield per acre without fertilizers.		Calculated gain per acre.	
		Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
Plot 1..	20 loads stable manure	1536 lbs	2282 lbs	1317 lbs	1187 lbs	219 lbs	1095 lbs
Plot 2..	1000 lbs. S. C. rock ..... 66 lbs. nitrate of soda..... 16 lbs. sulphate of ammonia.. 100 lbs. muriate of potash	1447 lbs	1534 lbs	1252 lbs	1129 lbs	195 lbs	405 lbs
Plot 3..	500 lbs. acid S. C. rock... .... 66 lbs. nitrate of soda. ..... 16 lbs. sulphate of ammonia.. 100 lbs. muriate of potash	1523 lbs	1449 lbs	1043 lbs	940 lbs	480 lbs	103 lbs
Plot 4..	No manure.....	1304 lbs	1176 lbs				

Last year's report of this work with a barley crop shows that the acid South Carolina rock produced the largest increase in the yield of grain, that stable manure produced the next largest increase and the crude South Carolina rock the least. The result of this year's work shows that the same order is maintained with the oat crop.

Reference to the report of last year shows that peas gave a larger increase with crude South Carolina rock than with acid rock. Too little data has been obtained from which to form sweeping generalizations as to relative ability of different classes of plants to gather their phosphoric acid from crude phosphates. But the writer is inclined to the belief, from the results obtained on this field and on Experimental Field No. 1, together with those obtained in the Leland experiment, a report of which follows, that leguminous plants are better adapted to this purpose than the cereals.

On Peas as a Crop to Precede Grain.

Leguminous plants have been designated as collectors of nitrogen and the cereals as dissipators of nitrogen. Many practical men have generalized from this that all leguminous crops are

especially fitted to precede the cereals as collectors of nitrogen for the latter crop. This view of the case is probably correct, when a considerable portion of the leguminous plant is left upon the ground, as with clover. The theory may well be questioned, however, so far as such crops as peas and beans are concerned, they having no large roots to leave in the soil, and with which the entire ærial portion of the plant is removed.

In connection with the experimental work described above a little data bearing on this point has incidentally been obtained.

It has already been noted that the north half of each of the plots on Experimental Field No. 2 was last year cropped with peas and the south half with barley, and that the entire field was cropped with oats this year.

Table L shows the yield of oats and straw per plot and per acre as divided between the north and south half of each plot.

TABLE L.

Number of plot.	Yield of grain per plot in 1891.	Yield of straw per plot in 1891.	Yield of grain per acre in 1891.	Yield of straw per acre in 1891.
No. 1, N. half....	1952 lbs. oats.	3148 lbs. oat straw.	1562 lbs. oats.	2518 lbs. oat straw.
S. half....	1888 lbs. oats.	2557 lbs. oat straw.	1510 lbs. oats.	2046 lbs. oat straw.
No. 2, N. half....	1590 lbs. oats.	2150 lbs. oat straw.	1272 lbs. oats.	1720 lbs. oat straw.
S. half....	2029 lbs. oats.	1686 lbs. oat straw.	1623 lbs. oats.	1349 lbs. oat straw.
No. 3, N. half....	1889 lbs. oats.	1921 lbs. oat straw.	1513 lbs. oats.	1537 lbs. oat straw.
S. half....	1918 lbs. oats.	1702 lbs. oat straw.	1534 lbs. oats.	1362 lbs. oat straw.
No. 4, N. half....	1594 lbs. oats.	1456 lbs. oat straw.	1275 lbs. oats.	1165 lbs. oat straw.
S. half....	1667 lbs. oats.	1484 lbs. oat straw.	1334 lbs. oats.	1187 lbs. oat straw.

An examination of this table shows that, with the exception of plot No. 1, to which stable manure was applied, that portion devoted to peas last year gave a smaller yield of oats this year than the portion on which barley was produced last year.

The large difference in the yield between the north and south halves of plot No. 2 can, in part, be explained by the fact that witch grass gained a footing on the north half while the south half was free from it. The yield on the north half was doubtless depressed somewhat on that account. But plots 3 and 4 contained no witch grass and the results obtained from them show nothing favorable to the theory that peas are a better crop to precede a cereal than a cereal.

An Experiment to Test the Relative Ability of Different Crops to Obtain Phosphoric Acid From Crude Phosphates.

This experiment was conducted for the Station by H. L. Leland, of East Sangerville, on a slaty gravel soil. Great credit is due him for the care with which the details of the work were carried out.

A field of three acres, whose dimensions were 20 rods by 24 rods, was divided into three parts, each containing just an acre, with dimensions 8 rods by 20 rods. To the first acre there were applied 500 lbs. of dissolved bone black and 100 lbs. of nitrate of soda; to the second acre there were applied 1000 lbs. of raw South Carolina rock and 100 lbs. of nitrate of soda; to the third acre, 500 lbs. of a Caribbean Sea guano and 100 lbs. of nitrate of soda were applied.

Each acre was then divided into twenty plots one rod wide and eight rods long, containing one-twentieth of an acre, and seeded as shown in the opposite diagram:

Plot.	FIRST ACRE. 500 lbs. dissolved bone-black and 100 lbs. nitrate of soda per acre.	SECOND ACRE. 1000 lbs. South Carolina rock, and 100 lbs. nitrate of soda per acre.	THIRD ACRE. 500 lbs. Caribbean Sea guano and 100 lbs. nitrate of soda per acre.
1	Clov	Clover.	Clover.
2	Oats.	Oats.	Oats.
3	Peas.	Peas.	Peas.
4	Turnips.	Turnips.	Turnips.
5	Wheat.	Wheat.	Wheat.
6	Beans.	Beans.	Beans.
7	Potatoes.	Potatoes.	Potatoes.
8	.....	.....	.....
9	Corn.	Corn.	Corn.
10	Barley.	Barley.	Barley.
1*d*	Clover.	Clover.	Clover.
2*d*	Oats.	Oats.	Oats.
3*d*	Peas.	Peas.	Peas.
4*d*	Turnips.	Turnips.	Turnips.
5*d*	Wheat.	Wheat.	Wheat.
6*d*	Beans.	Beans.	Beans.
7*d*	Potatoes.	Potatoes.	Potatoes.
8*d*	.....	.....	.....
9*d*	Corn.	Corn.	Corn.
10*d*	Barley.	Barley.	Barley.

20 Rods.

24 Rods.

Mr. Leland writes that the drought from the middle of May to the last of June seriously affected the crop. A neighboring farmer on land adjoining obtained only ten bushels of oats per acre.

The crops of oats, barley, wheat, peas and beans were so small that they were weighed without threshing. The corn was destroyed by grubs and was counted an entire failure.

The following table shows the yields of the various plots and the amounts and kinds of fertilizers used:

Crop.		500 lbs. dissolved bone-black and 100 lbs. nitrate of soda per acre.	1,000 lbs. South Carolina rock and 100 lbs. nitrate of soda per acre.	500 lbs. Caribbean Sea guano and 100 lbs. nitrate of soda per acre.
Plot 1..	Clover . .	Fair.	Best at close of season.	Very poor.
" 2 .	Oats . . .	Total crop 115 lbs.	Total crop 89 lbs.	Total crop 75 lbs.
" 3..	Peas . . .	" " 105 "	" " 110 "	" " 51 "
" 4..	Turnips .	351 "	369 "	Failure.
" 5..	Wheat . .	Total crop 120 lbs.	Total crop 105 "	Total crop 65 lbs.
" 6..	Beans . .	" " 63 "	" " 62 "	" " 54 "
" 7..	Potatoes .	228 "	210 "	153 "
" 8..	. . . .	. . . . .	. . . . .	. . . . .
" 9..	Corn . . .	Failure.	Failure.	Failure.
" 10..	Barley . .	Total crop 80 lbs.	Total crop 75 lbs.	Total crop 64 lbs.
" 1*d*.	Clover . .	Fair.	Best at close of season.	Very poor.
" 2*d*.	Oats	Total crop 111 lbs.	Total crop 83 lbs.	Total crop 70 lbs.
" 3*d*.	Peas . . .	" " 97 "	" " 103 "	" " 52 "
" 4*d*	Turnips .	340 "	361 "	Failure.
" 5*d*.	Wheat . .	Total crop 119 "	Total crop 102 "	Total crop 61 "
" 6*d*.	Beans . .	" " 66 "	" " 72 "	" " 43 "
" 7*d*.	Potatoes .	223 "	211 "	146 "
" 8*d*.	. . . .	. . . . .	. . . . .	. . . . .
" 9*d*.	Corn . . .	Failure.	Failure.	Failure.
" 10*d*.	Barley . .	Total crop 77 lbs.	Total crop 78 lbs.	Total crop 62 lbs.

An examination of the yields of the different crops shows that the dissolved bone black has given with the majority of them the largest return and the Caribbean Sea guano the least.

With peas and turnips South Carolina rock seems to have been more effective than dissolved bone black. This point is brought out quite sharply. The fact that turnips respond to manuring with some crude phosphates has been noted by other experimenters.

The results obtained in this experiment with South Carolina rock on peas agree very closely with the results obtained from all other experiments made by the Station covering this point.

Growing Mixed Grains Compared with Growing Grains Separately.

In accordance with the recommendation of the Station Council, trials have been made to test the advantages of growing wheat and oats mixed as compared with growing them separately. Six plots were measured off, 43.6 feet by 240 feet, on land that had been plowed the previous fall and manured at the rate of five cords of stable manure per acre. The seed was sown broadcast May 7th and crop harvested August 24th.

The following table shows the arrangement of the plots, the amount of seed applied and the yield per plot and per acre.

Number of plot.	Seed per plot.	Yield of grain per plot.	Yield of straw per plot.	Yield of grain per acre.	Yield of straw per acre.
1	12 lbs. oats.....	451.5 lbs.	563.5 lbs.	2052 lbs.	2561 lbs.
2	8 lbs. oats, 8 lbs. wheat...	367.0 "	593.0 "	1667 "	2696 "
3	24 lbs. wheat.....	314.5 "	515.5 "	1429 "	2343 "
4	12 lbs. oats.....	405.0 "	485.0 "	1841 "	2204 "
5	8 lbs. oats, 8 lbs. wheat...	343.5 "	546.5 "	1561 "	2484 "
6	24 lbs. wheat.....	307.0 "	583.0 "	1391 "	2650 "

The trial is decidedly in favor of oats separately, as compared with oats and wheat mixed, and oats and wheat mixed, as compared with wheat alone.

These results are in opposition to the teachings of many of our best farmers. A few years ago similar trials were made on the college farm of mixtures of oats and peas which resulted in showing that a larger number of pounds of peas could be produced alone than of a mixture of oats and peas, and that more pounds of the mixture of oats and peas than of oats alone.

Conclusion.

The conclusion of the writer is that the crop that yields the largest number of pounds per acre when grown alone will not be benefited by mixing with a crop that produces a less number of pounds per acre.

TRIALS OF SPRING AND FALL MANURING.

On a section of a field, lying west of Experiment Field No. 2, two plots were laid off, one of which was manured in the fall at the rate of five cords of stable manure per acre, and the other manured at the same rate in the Spring. The plots, owing to the shape of the field, are of unequal size but quite uniform in character of soil. On account of the variation in size the yields per plot do not show the relative effect of the manure; but the yields per plot have been calculated per acre and are shown on the following table.

These plots were sown to oats May 2 and harvested August 24.

	Dimensions of plots.	Time of manuring.	Yield of grain per plot.	Yield of straw per plot.	Yield of grain per acre.	Yield of straw per acre.
Plot 1.	143 ft.x84 ft.....	Fall.....	395.5 lbs.	654.5 lbs.	1327 lbs.	2190 lbs.
Plot 2.	161 ft.x74 ft.....	Spring.....	411.5 lbs.	593.5 lbs.	1507 lbs.	2175 lbs.

The Spring manuring has given the largest yield of grain, and the Fall manuring the largest yield of straw per acre. At some future time this work will be repeated.

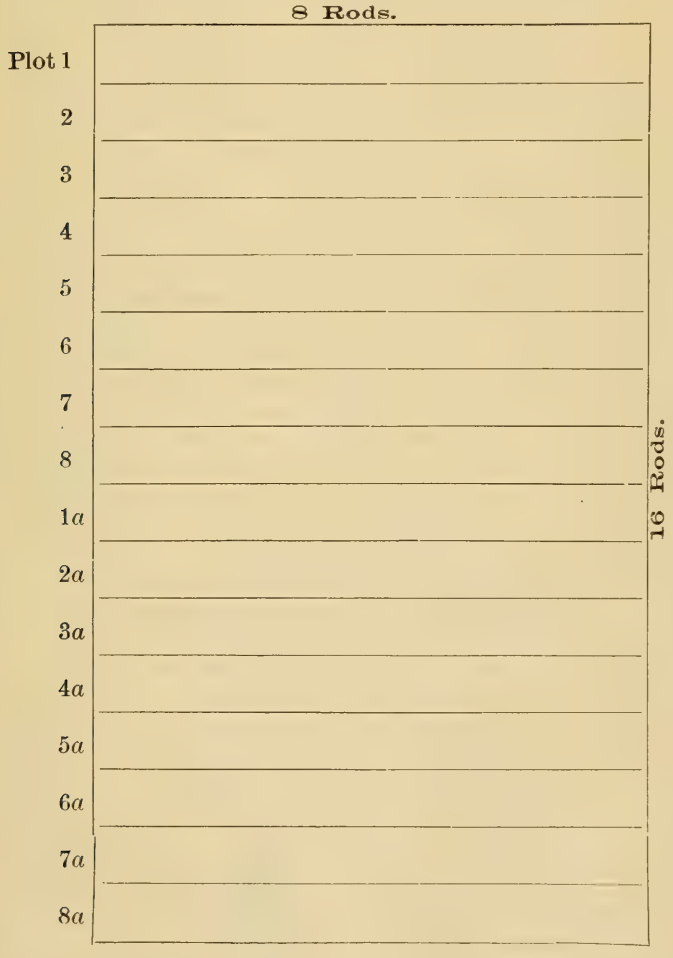
Farmers' Experiments.

It has been the policy of the Station to encourage farmers in studying the application of well known facts in connection with plant growth and soils to the business of producing crops. To this end experimental sets of fertilizers have been sent from time to time to farmers who desired to undertake work of this kind. Eight such sets were shipped to farmers last Spring. Reports have been received from five of them which are of local interest in the neighborhoods where the experiments were carried out.

These sets of fertilizers supplied phosphoric acid, potash and nitrogen, separately, and in various combinations, and were designed to test the ability of the soil to supply one or more of these substances to the crop in such quantities as to render their application superfluous or unprofitable.

Each experiment involved the cultivation of sixteen one-twentieth acre plots as shown in the diagram below.

The plots 1*a* to 8*a* are duplicates of plots 1 to 8. The kinds and quantities of fertilizers used on each plot are indicated in the report of each experiment. Dissolved bone black furnishes phosphoric acid, nitrate of soda, nitrogen, and muriate of potash, potash.



Experiment of H. C. Towsand, Fort Fairfield.

Crop, potatoes, planted May 23 in checks 32 inches each way, making 288 hills per plot. Whole seed was used, just below market size. Rust struck the tops August 12 which greatly reduced the yield. Potatoes dug and weighed Sept. 26-29. Below are given the results:

Fertilizers applied.	Amount of fertilizer per acre.	No. of plot.	Weight of crop in pounds.	No. of plot.	Weight of crop in pounds.	Average yield of combined plots per acre.
	lbs.					bush.
Dissolved bone-black	500					
Nitrate of soda	150	1	578	1*a*	564	190.3
Muriate of potash	100					
Dissolved bone-black	500					
Muriate of potash	100	2	511	2*a*	597	184.7
Dissolved bone-black	500					
Nitrate of soda	150	3	516	3*a*	559	179.3
Dissolved bone-black	500	4	455	4*a*	503	159.7
Muriate of potash	100					
Nitrate of soda	150	5	408	5*a*	440	141.3
Nitrate of soda	150	6	418	6*a*	415	138.8
Muriate of potash	150	7	370	7*a*	421	131 8
No manure		8	335	8*a*	374	118.2

The table below shows the increase of crop on manured plots over unmanured plots calculated per acre, and the cost of fertilizers used, on the basis of dissolved bone black at $24.00 per ton, muriate of potash at 2 cents per pound and nitrate of soda at 2 cents per pound, also cost of increase per bushel.

Plots.	Increase in crop per acre due to fertilizers.	Cost of fertilizer per acre.	Cost of increase per bushel.
1 and 1*a*	72.1 bushels.	$11.00	15.2 cents.
2 and 2*a*	66.5 "	$8.00	12.0 "
3 and 3*a*	61.3 "	$9.00	14.3 "
4 and 4*a*	41.5 "	$6.00	14.5 "
5 and 5*a*	23.1 "	$5.00	21.2 "
6 and 6*a*	20.6 "	$3.00	14.6 "
7 and 7*a*	13.6 "	$2.00	14.7 "
8 and 8*a*			

In this experiment all of the fertilizers caused an increase in the crop but the combination of dissolved bone black and muriate of potash produced the increase at the least cost per bushel.

Experiment of F. A. Herrick; Easton.

Crop, potatoes, planted June 1 by hand, 5 rows to a plot and 50 hills in a row. No misfortune happened to the crop except missing hills. As the missing hills varied with the different plots, in the table the yields are calculated for 250 hills per plot.

Fertilizers applied.	Amount of fertilizers per acre in lbs.	No. of plot.	Weight of crop per plot in lbs.	No. of plot.	Weight of crop per plot in lbs.	Average yield of combined plots per acre, bush.
Dissolved bone-black Nitrate of soda Muriate of potash	500 150 100	1	398	1*a*	413	135.3
Dissolved bone-black Muriate of potash	500 100	2	319	2*a*	413	122.0
Dissolved bone-black Nitrate of soda	500 150	3	363	3*a*	408	128.5
Dissolved bone-black	500	4	310	4*a*	330	106.7
Muriate of potash Nitrate of soda	100 150	5	161	5*a*	181	57.0
Nitrate of soda	150	6	126	6*a*	156	47.0
Muriate of potash	100	7	211	7*a*	151	60.3
No manure		8	215	8*a*	165	63.3

Table showing increase of crop on manured plots over unmanured plots and cost of increase per bushel at wholesale prices quoted above for fertilizers.

Plots.	Increase of plot per acre due to fertilizers.	Cost of fertilizers per acre.	Cost of increase per bushel.
1 and 1*a*	72.0 bushels.	$11.00	15.3 cents.
2 and 2*a*	58.7 "	$8.00	13.6 "
3 and 3*a*	65 2 "	$9.00	13.8 "
4 and 4*a*	43.4 "	$6.00	13.8 "
5 and 5*a*	—6.3 "	$5.00	
6 and 6*a*	—16.3 "	$3.00	
7 and 7*a*	—3 0 "	$2.00	
8 and 8*a*			

In this experiment nitrate of soda and muriate of potash mixed and separately seems to have worked absolute harm to the crop, though when combined with dissolved bone black they produced an increase in the crop. So far as cost of increase per bushel is concerned, the results are slightly in favor of dissolved bone black and muriate of potash.

Experiment of Geo. Ingraham, Houlton.

Crop, potatoes; on clay loam, hill land; in grass previous season; cut about one-half ton of hay per acre; plowed in Fall of 1890; ground well harrowed; furrowed with a horse hoe at time of planting; fertilizers drilled in the furrow and well mixed with the soil before dropping the seed; planted to Beauty of Hebrons, 10 bushels per acre. The rust struck the vines early in the season and at the time of digging about one-half of the crop proved rotten. The table below shows the yields of sound potatoes only.

Fertilizers applied.	Amount of fertilizers per acre in pounds.	No. of plot.	Weight of crop per plot in lbs.	No. of plot.	Weight of crop per plot in lbs.	Average yield of combined plots per acre, bush.
Dissolved bone-black Nitrate of soda Muriate of potash	500 150 100	1	457	1*a*	461	153.0
Dissolved bone-black Muriate of potash	500 100	2	473	2*a*	459	155.3
Dissolved bone-black Nitrate of soda	500 150	3	458	3*a*	470	154.7
Dissolved bone-black	500	4	488	4*a*	465	158.8
Muriate of potash Nitrate of soda	100 150	5	433	5*a*	427	143.2
Nitrate of soda	150	6	422	6*a*	430	142.0
Muriate of potash	100	7	428	7*a*	440	144.7
No manure		8	215	8*a*	261	78.0

Table showing increase of crop on manured plots ove. unmanured plots and cost of increase per bushel at wholesale prices quoted above for fertilizers.

Plots.	Increase of crop per acre due to fertilizers.	Cost of fertilizers per acre.	Cost of increase per bushel.
1 and 1*a*	75.0 bushels.	$11.00	14.6 cents.
2 and 2*a*	77.3 "	$8.00	10.3 "
3 and 3*a*	76.7 "	$9.00	11.7 "
4 and 4*a*	80.8 "	$6.00	7.4 "
5 and 5*a*	65.2 "	$5.00	7.6 "
6 and 6*a*	64.0 "	$3.00	4.7 "
7 and 7*a*	66.7 "	$2.00	3.0 "
8 and 8*a*			

In this experiment Mr. Ingraham judged that one-half of the potatoes were rotten and reported the weight of the sound ones only, so that no accurate estimate can be made of the effect of

the fertilizers. All of the fertilizers increased the crop largely, however. The cost of the increase is least with muriate of potash, while the largest crop was produced with dissolved bone black.

EXPERIMENT OF CHARLES S. POPE, MANCHESTER.

The crop grown was barley. The combined weights of the crops on the duplicate plots are given so that the weights represent the grain produced on one-tenth of an acre instead of a twentieth.

Fertilizers applied.	Amount of fertilizers per acre in lbs.	No. of plot.	Weight of grain in lbs.	Weight of straw in lbs.	Yield of barley per acre, bush.
Dissolved bone-black	500	1 and 1*a*	159	260	33.1
Nitrate of soda	150				
Muriate of potash	100				
Dissolved bone-black	500	2 and 2*a*	145	215	30.2
Muriate of potash	100				
Dissolved bone-black	500	3 and 3*a*	138	216	26.7
Nitrate of soda	150				
Dissolved bone-black	500	4 and 4*a*	109	176	22.7
Muriate of potash	100	5 and 5*a*	91	172	19.0
Nitrate of soda	150				
Nitrate of soda	150	6 and 6*a*	73	165	15.2
Muriate of potash	100	7 and 7*a*	71	168	14.8
No manure		8 and 8*a*	61	147	12.7

Table showing increase in barley crop on manured plots over unmanured plots and cost of increase per bushel at wholesale prices quoted above.

Plots.	Increase of crop per acre due to fertilizers.	Cost of fertilizer per acre.	Cost of increase per bushel.
1 and 1*a*	20.4 bushels.	$11.00	55 cents.
2 and 2*a*	17.5 "	$8.00	46 "
3 and 3*a*	14.0 "	$9.00	64 "
4 and 4*a*	10.0 "	$6.00	60 "
5 and 5*a*	6.3 "	$5.00	79 "
6 and 6*a*	2.5 "	$3.00	120 "
7 and 7*a*	2 1 "	$2.00	95 "
8 and 8*a*			

In this experiment dissolved bone black and muriate of potash produced the increase in crop at the least cost per bushel, while dissolved bone black, muriate of potash and nitrate of soda caused the largest gain in crop.

EXPERIMENT OF I. O. WINSLOW, ST. ALBANS.

Crop, corn; soil, gravelly loam; plots, one-thirtieth of an acre instead of one-twentieth; crop weighed in the ear with the husks on.

Fertilizers applied.	Amount of fertilizers per acre in lbs.	No. of plot.	Weight of corn per plot in ears.	No. of plot.	Weight of corn per plot in ears.	Average weight of corn per plot in ears.
			lbs.		lbs.	lbs.
Dissolved bone-black	750	1	180	1*a*	240	210
Muriate of potash	150					
Nitrate of soda	225					
Dissolved bone-black	750	2	175	2*a*	245	210
Muriate of potash	150					
Dissolved bone-black	750	3	93	3*a*	156	130
Nitrate of soda	225					
Dissolved bone-black	750	4	71	4*a*	135	103
Muriate of potash	150	5	202	5*a*	221	212
Nitrate of soda	225					
Nitrate of soda	225	6	121	6*a*	69	95
Muriate of potash	150	7	194	7*a*	92	143
No manure		8	77	8*a*	68	73

Table showing the yield of corn on the ear, in the husk, on manured plots over unmanured plots, together with the cost of fertilizers at wholesale prices quoted above.

Plots.	Increase of crop per acre due to fertilizers.	Cost of fertilizers per acre.
1 and 1*a*	2055 lbs.	$16.50
2 and 2*a*	2055 "	12.00
3 and 3*a*	855 "	13.50
4 and 4*a*	450 "	9.00
5 and 5*a*	2085 "	7.50
6 and 6*a*	229 "	4.50
7 and 7*a*	850 "	3.00
8 and 8*a*		

In this experiment nitrate of soda and muriate of potash gave not only the largest yield but produced the increase in crop at the least expense for fertilizers. Muriate of potash and dissolved bone black gave the same yield as muriate of potash, nitrate of soda and dissolved bone black.

These experiments demonstrate that commercial fertilizers may be used to great advantage by all of the experimenters. They

also show that in order to obtain the greatest profit they must be used with a knowledge of what the soil can furnish as well as the requirements of the crop.

In view of the fact, that in four out of five of these experiments the increase in the crop was produced at least expense with either potash, or phosphoric acid, or a combination of the two, it would be well for the experimenters to continue their studies of the effect of application of those materials in a rotation of crops in which the clover has a place, relying on the clover to keep up the nitrogen supply. In the fifth experiment, in which not only the largest crop, but the crop in which the increase was produced at least expense, came from a manuring with muriate of potash and nitrate of soda, it would be advisable to try an experiment to see if the clover in rotation could not be made to take the place of the nitrate of soda.

REPORT OF METEOROLOGIST.

PRESIDENT FERNALD, METEOROLOGIST TO THE STATION.

MAINE EXPERIMENT STATION.

Lat, 44°, 54′, 2″, N. Long, 68°, 40′, 11″, W.

In the meteorological work undertaken by the Experiment Station, the object sought is not so much the observing and reporting of general atmospheric phenomena as the careful study of the special meteorological conditions which are more or less intimately connected with practical agriculture.

A reliable determination of these conditions from which safe deductions can be made, necessarily involves observations continued through a series of years.

Accordingly in commencing the work of observation, a plan was formed which has been strictly adhered to during the past three years.

This report contains a summary of results afforded by about thirty thousand independent observations. Under each division of the subject here considered, the observations of the past year are continuous to those of the two preceding years.

Since the instruments have remained unchanged in position during the three years under notice, I draw freely from my former reports, in presenting the arrangement of instruments and the other needful descriptive or explanatory data.

The most of the instruments employed were manufactured by H. J. Green of Brooklyn, N. Y. Mr. Robert H. Fernald of Orono, has been observer during the three years that this work has been carried on. In this report the results of observations made during the years 1889, 1890, and 1891, are combined.

The several problems considered appear in definite order, in the following pages. The first to which attention has been given, is a determination of the percentage of moisture in forest as compared with that in open field.

The arrangement of instruments for this investigation is herewith submitted.

Hygrometer No. 1 is placed in a wooden stand constructed for thermometrical instruments and located in the open field remote from buildings. Hygrometer No. 2 also is enclosed in a wooden box, perforated to allow a free circulation of air, and located also in the open field. Hygrometer No. 3 is also enclosed in a perforated box attached to a tree in a moderately dense forest. Hygrometer No. 4 is placed in a similar box attached to a tree in a portion of the forest a little more open than that in which No. 3 is located, but near which is a running brook except during the driest part of the summer.

Each hygrometer is about four feet above the surface of the ground. Readings are taken three times daily, at 7 A. M., at 1 P. M., and at 7 P. M., local time.

Observations were commenced April 5, 1889 and they have been continued through the growing seasons of 1889, 1890, and 1891.

The monthly averages are given in the following tables on the scale of 100.

PERCENTAGES OF MOISTURE.

HYGROMETER NO. 1.—IN OPEN FIELD.

	1889.			1890.			1891.			
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	Mean
April,	81	53	66	74	50	58	85	61	67	66
May,	84	60	71	81	62	74	82	57	67	71
June,	88	67	81	83	72	75	83	62	71	76
July,	85	65	75	85	74	79	87	61	72	76
August,	95	70	80	90	63	77	89	67	83	79
September,	93	68	83	93	76	85	92	67	84	82
October,	94	66	79	90	62	79	90	63	80	78
Mean results,	89	64	76	85	66	75	87	63	75	76

HYGROMETER NO. 2.—IN OPEN FIELD.

	1889.			1890.			1891.			
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	Mean
April,	78	52	65	70	46	56	84	62	70	65
May,	80	53	68	78	61	74	80	55	68	68
June,	84	66	74	78	68	75	82	62	73	73
July,	79	60	69	80	63	71	86	62	75	72
August,	87	67	75	88	62	73	87	65	80	76
September,	91	60	81	91	67	83	91	67	85	80
October,	93	66	81	91	62	79	91	65	82	79
Mean results,	85	61	72	82	61	73	86	63	76	73

HYGROMETER NO. 3.—IN FOREST.

	1889.			1890.			1891.			
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	Mean
April,	81	62	69	78	61	69	90	73	77	76
May,	83	63	73	87	74	81	86	68	75	77
June,	89	80	84	87	77	82	88	81	84	84
July,	94	86	91	93	85	83	92	80	85	90
August,	91	89	93	94	80	84	95	81	88	88
September,	96	88	92	96	87	92	95	81	92	91
October,	96	90	90	96	86	90	92	77	86	89
Mean results,	90	80	85	90	79	83	91	77	84	85

HYGROMETER NO. 4.—IN FOREST.

	1889.			1890.			1891.			
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	Mean
April,	83	65	77	79	60	71	91	74	82	76
May,	89	66	80	88	73	84	87	69	78	79
June,	92	81	86	89	77	84	90	74	82	84
July,	93	79	87	91	79	85	93	79	86	86
August,	95	86	91	91	78	85	96	78	90	88
September,	96	83	90	97	86	92	96	79	92	90
October,	96	80	90	94	80	89	92	76	87	87
Mean results,	92	77	86	90	76	84	92	75	85	84

Percentages of Moisture.

RESULTS FOR 1889, 1890, AND 1891, COMBINED.

	7 A. M.	1 P. M.	7 P. M.	Mean
Hygrometer No. 1, in open field,	87	64	75	75
" " 2, " " "	84	62	74	73
" " 3, in forest,	90	79	84	84
" " 4, " "	91	76	85	84

Regarding the mean results from hygrometers Nos. 1 and 2 as indicating percentages for the open field, we have the following summary of results:

	7 A. M.	1 P. M.	7 P. M.	Mean
Percentages of moisture, open field,	85	63	74	74

Regarding the mean results from hygrometers No. 3 and 4 as indicating percentages for forests only moderately dense, we have the following summary results:

	7 A. M.	1 P. M.	7 P. M.	Mean
Percentages of moisture, forest,	90	78	84	84

Comparing results, open field and forest, we have excess of moisture in forest above that in open field expressed in percentages.

7 A. M.	1 P. M.	7 P. M.	Mean
5	15	10	10

It thus appears from observations covering the period of growth of three years, that the excess of moisture in forest above that of open field in the morning, amounts to but 5 per cent., while in the middle of the day it rises to 15 per cent., and at night-fall drops down to 10 per cent., and that the mean excess for the day is 10 per cent. In a very dense forest the percentage of excess would undoubtedly rise much higher. The presence of patches of forest in any region exerts a marked influence on the hygroscopic conditions of the atmosphere, and this condition, in turn, is an important factor in the growth of vegetation.

Soil Temperatures.

In this investigation a knowledge of the temperature of the soil at different depths, during the growing season, is sought, and ultimately the law which represents the rate of change of temperature at different depths.

The periods covered by the experiment are from May 1 to Nov. 1, 1889, from April 1 to Nov. 1, 1890, and from April 1 to Nov. 1, 1891, with thermometers placed in the soil to the depths of 1, 3, 6, 9, 12, 24 and 36 inches.

The thermometers have been allowed to remain in place during the winters intervening between the periods of observation.

Their location is in the open field, near hygrometer No 2, in the tract of land assigned to the Station for experimental purposes and devoted to farm experiments. The character of the soil is regarded, therefore, as representative of that on which the field experiments by the Station are carried on.

A summary of results for the three seasons by monthly averages is given in the annexed tables.

SOIL THERMOMETERS—1889.

	1 inch.			3 inches.			6 inches.			9 inches.			12 inches.			24 inches.			36 inches.		
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
May	51.77	62.92	59.20	51.50	60.33	59.70	52.92	55.21	57.04	53.49	53.31	55.44	52.46	52.15	53.21	48.84	49.06	49.01	46.28	46.42	46.48
June	61.94	71.54	67.56	61.38	69.62	67.76	61.85	68.43	65.35	62.07	62.27	63.51	61.26	61.10	61.79	57.23	57.43	57.41	54.36	54.54	54.52
July	63.41	72.10	68.89	63.10	70.86	69.54	64.25	66.51	67.48	64.93	65.15	66.27	64.30	64.02	64.29	60.99	61.14	61.03	58.50	58.62	58.57
August	61.18	69.59	66.90	61.75	68.91	68.01	62.90	64.83	66.01	59.82	63.88	65.01	63.31	63.10	63.31	60.96	61.10	60.97	59.16	59.31	59.23
September	57.11	61.56	61.45	57.74	63.01	62.89	59.47	60.25	61.29	60.29	60.20	60.93	60.30	60.21	60.04	59.42	59.51	59.36	58.40	58.51	58.37
October	42.80	43.59	45.50	43.80	47.31	46.72	46.06	46.48	47.12	47.21	46.97	47.32	48.17	47.83	47.85	50.63	50.65	50.54	51.66	51.66	51.61
Mean	56.37	63.55	61.58	56.54	63.34	62.44	57.91	60.28	60.71	57.97	58.63	59.75	58.30	58.06	58.41	56.34	56.48	56.39	54.84	54.73	54.79
Mean temperature for six months	° 60.50			° 60.77			° 59.63			° 58.78			° 58.26			° 56.40			° 54.79		

SOIL THERMOMETERS—1890.

	1 inch.			3 inches.			6 inches.			9 inches.			12 inches.			24 inches.			36 inches.		
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M	7 P.M.	7 A.M.	1 P.M	7 P.M.	7 A.M.	1 P.M.	7 P.M.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
April	33.74	40.35	36.89	36.53	38.12	37.11	34.32	34.55	35.13	33.56	34.09	34.29	34.57	34.55	34.75	34.81	34.83	34.95	35.31	35.39	35.37
May	50.38	54.80	51.53	47.63	51.67	53.40	49.40	50.26	51.49	49.29	49.27	49.72	48.80	48.68	48.82	45.72	45.55	45.84	43.27	43.72	43.77
June	56.06	60.05	59 68	55.91	60.44	60.07	56.11	56.78	57.55	55.85	55.95	56.32	55.99	55.95	55.82	53.52	53.18	53.27	50.85	50.94	51.96
July	62.82	64.69	64.03	62.66	66.93	66.81	65.91	64.11	64.87	62.85	62.95	63.88	62.70	62.60	62 78	58.77	58.84	58.77	56.25	56.28	56.34
August	61.80	68.20	67.28	62.15	67.60	67.41	63.69	65.08	66.26	63.91	64.16	64.83	63.87	63.84	63.91	61.72	62.09	61.34	59.43	59.40	59.39
September	56.51	59 83	59.43	57.44	58.93	59.62	58.21	58.56	59.34	58.36	58.30	58.59	58.73	58.58	58.56	58.15	58.43	58.37	57.73	58.05	57.65
October	45.37	47.17	46.67	45 77	47.16	46.76	47.09	47.10	47.23	47.40	47.32	47.66	48.81	48.72	48.59	51.08	50.97	50.86	52.07	52.04	52.00
Mean	52.38	56.44	55.07	52.58	56.29	55.88	53.51	53.78	54.55	53.03	53.15	53.61	53.35	53.27	53.32	51.97	51.99	51.93	50.70	50.83	50.78

Mean temperature for seven months,	° 54.63	° 54.92	° 53.96	° 53.26	° 53.31	° 51.96	° 50 77

SOIL THERMOMETERS—1891.

	1 inch.			3 inches.			6 inches.			9 inches.			12 inches.			24 inches.			36 inches.		
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
April	37.70	42.48	42.34	37.69	42.32	42.41	39.03	39.81	41.40	37.64	37.68	39.93	38.80	38.69	38.58	36.87	36.96	37.01	37.46	37.53	37.53
May	46.54	54.03	52.93	54.31	53.73	52.87	47.49	49.27	51.24	47.83	48.22	49.36	47.64	47.63	47.90	45.00	45.14	45.20	43.78	43.49	43.50
June	59.18	65.42	64.53	59.10	64 80	64.21	59.43	60.40	61.73	59.23	58.96	59.67	58.79	58.37	58.60	54.00	54.12	54.11	51.25	51.35	51.37
July	62.70	68.59	67.44	62.78	67.56	67.10	63.08	64.23	65.18	63.17	63.18	62.85	62.39	62 14	62.44	58.16	58.25	58.26	55.75	55.82	55.82
August	62.45	69.07	67.46	62.59	68.03	67.45	63.98	64.97	66.62	63.93	63.99	64.99	63.80	63.59	63.91	60.72	60.83	60.76	58.66	58.75	58.37
September	58.82	62.88	62.41	59.00	62.85	62.55	60.43	60.99	62.00	60.57	60.48	61.21	60.77	60.60	60.73	59.67	59.70	59.65	58.53	58.61	58.36
October	46.03	48.78	47.94	46.20	48.86	48.22	48.20	48.54	48.81	48.78	48.57	49.17	50.02	49.86	49.77	52.74	52.67	52.53	53.61	53 58	53.50
Mean	53.35	58.75	57.86	54.52	58.31	57.83	54.52	55.46	56.71	54.45	54.44	55.34	54.60	54.41	54.56	52 45	52.52	52.50	51.29	51.3	51.49
Mean temperature for seven months,		° 56.65			° 56.89			° 55.56			° 54.74			° 54.52			° 52.49			° 51.36	

In order that comparisons may be made between soil temperatures at different depths and the air temperatures during the same months and in the same locality, the following tables are added:

THERMOMETER IN THE OPEN AIR.

(Locality the same as that of the soil thermometers.)

1889.

	7 A.M. °	1 P.M. °	7 P.M. °	Mean. °
May,	52.95	68.30	59.47	60.24
June,	63.36	74.27	68.07	68.57
July,	65.12	75.75	70.86	70.58
August,	59.97	74.20	66.81	66.99
September,	54.39	70.86	61.55	62.27
October,	37.41	52.80	44.05	44.75
Mean,	55.53	69.36	61.80	62.23

1890.

	7 A.M. °	1 P.M. °	7 P.M. °	Mean. °
April,	35.76	49.02	42.55	42.44
May,	49.16	60.60	53.58	54.45
June,	57.95	67.64	62.76	62.78
July,	67.10	76.19	71.85	71.71
August,	61.50	73.78	68.84	68.04
September,	52.04	66.16	58.52	58.91
October,	37.70	53.19	45.63	45.51
Mean,	51.60	63.80	57.68	57.69

1891.

	7 A.M. °	1 P.M. °	7 P.M. °	Mean. °
April,	36 33	48.26	43.64	42.74
May,	47.07	61 75	53.30	54.04
June,	58.28	72.42	65.38	65.36
July,	64.08	76.05	68.81	69.65
August,	62.07	74.94	67.47	68.16
September,	56.13	69.72	61.80	62.55
October,	38.11	54.02	45.56	45.90
Mean,	51.72	65.31	57.99	58.34

TABLES SHOWING CHANGES OF TEMPERATURE IN THE SOIL FOR INCREASED DEPTHS.

1889.

Depth of Thermometer.	Mean temperature for 6 mos., May to Oct. inclusive.	Difference in mean temperatures.	Changes in temperature for one inch.
	°	°	°
1 inch	60.50		
		+0.27	+0.13
3 inches	60.77		
		—1.14	—0.38
6 inches	59.63		
		—0.85	—0.28
9 inches	58.78		
		—0.52	—0.17
12 inches	58.26		
		—1.86	—0.15
24 inches	56.40		
		—1.61	—0.13
36 inches	54.79		

1890.

Depth of Thermometer.	Mean temperature for 7 mos., April to Oct. inclusive.	Difference in mean temperatures.	Changes in temperature for one inch.
	°	°	°
1 inch	54.63		
		+0.29	+0.14
3 inches	54.92		
		—0.96	—0.32
6 inches	53.96		
		—0.70	—0.23
9 inches	53.26		
		+0.05	+0.02
12 inches	53.31		
		—1.35	—0.11
24 inches	51.96		
		—1.19	—0.10
36 inches	50.77		

1891.

Depth of Thermometer.	Mean temperature for 7 mos., April to Oct. inclusive.	Difference in mean temperatures.	Changes in temperature for one inch.
	°	°	°
1 inch	56.65		
		+0.24	+0.12
3 inches	56.89		
		—1.33	—0.44
6 inches	55.56		
		—0.82	—0.27
9 inches	54.74		
		—0.22	—0.07
12 inches	54.52		
		—2.03	—0.17
24 inches	52.49		
		—1.13	—0.09
36 inches	51.36		

An examination of the tables shows that the soil responds readily to the daily heat of the sun to the depth of three inches, less readily to the depth of six inches, in a moderate degree only to the depth of nine inches, and very slightly below twelve inches. To the depth of three inches the range between the morning and

the midday observations has been as high as fifteen degrees. The mean daily range at the depth of 1 inch during the period of observations was 5°.55; at the depth of three inches, 4°.77; at the depth 6 inches, 2°.00; at the depth of 9 inches, 1°.09, and below 12 inches very slight.

At the depth of 3 inches, the average temperature of the soil was somewhat higher than at the depth of 1 inch. The surface soil averaged about five degrees warmer than the soil 36 inches below the surface.

The rate of reduction of temperature with depth below the layer three inches from the surface is clearly shown in the foregoing tables.

It is interesting to notice how closely the changes in temperature for one inch accord with one another, in the different years, at corresponding depths.

The apparent rate of reduction of temperature with depth is vitiated, however, by the record of the 9-inch soil thermometer. This anomalous record is explained by the fact that at the end of the first season this thermometer was broken and a new one had to be substituted in its place. The contact of the latter with the soil was not precisely the same as that of the former or of the other instruments that had not been disturbed. Judging from the tables, another year will be needed to restore uniformity of condition among the several instruments. This accident, with the resulting error introduced, well illustrates the delicacy of the work carried on by means of the soil thermometers.

Comparing soil temperatures with air temperatures during the three seasons, the following mean results appear: At the depth of 1 inch, the temperature of the soil was lower than that of the air by 2°.16; at the depth of 3 inches, by 1°.89; 6 inches, by 3°.08; 9 inches, by 3°.83; 12 inches, by 4°.06; 24 inches, by 5°.80, and at the depth of 36 inches, by 7°11.

Terrestrial Radiation.

The heat radiated from the surface of the earth during the night reduces its temperature several degrees below that of the surrounding atmosphere. The amount of this radiation or the consequent reduction of temperature is approximately shown by comparing the readings of a terrestrial radiation thermometer with those of a minimum thermometer. In obtaining data for

the comparison given below, the minimum thermometer was four feet above the ground and the terrestrial radiation thermometer was within six inches of its surface. The results are based on monthly averages from May to October inclusive, 1889, from April to October inclusive, 1890, and from April to October inclusive, 1891.

TABLE SHOWING LOSS OF HEAT BY TERRESTRIAL RADIATION.

1889.

	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
	o	o	o	o	o	o	o
Mean of minimum temperatures.	46.63	53.25	55.08	53.65	49 07	33.91	48.50
Mean of Temp. from Ter. Rad. Ther.	38.48	49.20	50 59	47.66	44.60	28.48	43.17
Loss of heat by radiation	8.15	4.05	4.49	5.39	4.74	5.43	5.33

1890.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean
	o	o	o	o	o	o	o	o
Mean of minimum temperatures	29.17	42.52	48.71	53.61	53.52	45.32	36.05	44 13
Mean of Temp. from Ter. Rad. Ther.	19.95	37.10	42.10	44.55	46.25	38.40	27.14	36.50
Loss of heat by radiation	8.22	5.42	6.61	9.06	7.27	6.92	9.91	7.63

1891.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean
	o	o	o	o	o	o	o	o
Mean of minimum temperatures.	30.22	37.67	49.18	53.15	54.07	49.23	34.95	44.07
Mean of Temp. from Ter. Rad. Ther.	24.45	29.09	40.87	43.94	47.40	42.22	25.60	36.23
Loss of heat by radiation	5.77	8.58	8.31	9.21	6.67	7.01	9.35	7.84

On cloudy nights the difference in the reading of the two thermometers is small, and on exceptionally clear (dry) nights it is a maximum. The greatest range observed was 19°.5. On the morning of July 2, 1889, the radiation thermometer was the higher, showing that the moist air resting upon the surface of the ground served as a warm blanket, and that the amount of heat absorbed was greater than that radiated. From the table above it appears that the mean radiation for the three seasons was 6°.93.

SOLAR RADIATION.

The temperature of the atmosphere does not indicate the intensity of the sun's heat, as only a small percentage is absorbed as the rays are transmitted through the air. The maximum thermometer in the shade, therefore, does not give the intensity of solar radiation; neither does exposure of an ordinary thermometer to the direct rays of the sun, in consequence of the cooling effects

of draughts of air. In order to avoid the effects of currents of air, the *vacuum solar radiation thermometer* has been devised. "This consists of a blackened bulb radiation thermometer inclosed in a glass tube and globe, from which all air is exhausted. Thus protected from the loss of heat which would ensue if the bulb were exposed, its indications are from 20° to 30° higher, than when placed side by side with a similar instrument with the bulb exposed to the passing air." By the use of this instrument the amounts of solar radiation at different places and in different seasons at the same place are rendered comparable. The relations of solar intensity, as distinct from temperature of the air, to the growth and maturity of crops are worthy of careful investigation. High solar intensity maintained through the latter part of the growing season has an important bearing upon the complete ripening of vegetables and fruits and likewise upon their keeping qualities. From the wide range of observations undertaken by Experiment Stations with radiation thermometers, important deductions may reasonably be expected. I subjoin tables of results from the maximum thermometer and the thermometer for solar radiation, expressed in monthly averages.

1889.

	May.	June.	July.	Aug.	Sept.	Oct.	Mean
	°	°	°	°	°	°	°
Mean of readings, Sun Ther.	133.02	134.22	139.55	137.56	122.79	105.86	128.83
Mean of maximum temperatures	67.85	73.45	75.30	73.72	71.23	52.78	69.05
Excess of solar intensity	65.17	60.77	64.25	63.84	51.56	53.08	59.78

1890.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean
	°	°	°	°	°	°	°	°
Mean of readings, Sun Ther.	119.15	119.45	128.81	139.37	138.25	114.94	112.52	124.65
Mean of maximum Temp.	49.37	61.16	68.01	76.53	74.67	62.32	55.61	64.38
Excess of solar intensity	69.82	58.29	60.80	62.84	63.58	49.62	56.92	60.27

1891.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean
	°	°	°	°	°	°	°	°
Mean of readings, Sun Ther.	106.78	119.19	129.44	140.35	129.55	121.65	99.55	120.93
Mean of maximum Temp.	50.65	62.48	72.17	76.68	75.39	69.84	54.18	65.91
Excess of solar intensity	56.13	56.71	57.27	63.67	54.16	51.81	45.37	55.02

From the above records it appears that the average excess of solar intensity above that given by the maximum thermometer for the growing periods of 1889, 1890, and 1891, was 58°.36.

The season of greatest excess in this regard was that of 1890, a season noted for the perfect maturity of fruits and vegetables.

Amount of Sunshine.

The amount of sunshine as an essential factor in crop production is worthy of observation and record. Observations were commenced May 1, 1890, and the table below furnishes the summary for the six months following and for seven months, April to November, 1891.

Bright Sunshine in Hours.

1890.

	May.	June.	July.	Aug.	Sep.	Oct.	Mean.
Sunshine,	180	186	216	193	126	133	172
Hours per day, mean,	5.8	6.2	7.0	2.6	4.2	3.3	5.6

1891.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
Sunshine,	174	207	217	259	225	234	154	209
Hours per day, mean,	5.8	6.7	7.2	8.4	7 3	7.8	5.0	6.9

During the period covered by the above table, the average hours of bright sunshine per day were 6.3 or 46 per cent. of the possible amount.

Wind and Rain.

The velocity of the wind has been determined by a Robinson's Anemometer, with electrical recording apparatus, attached to the Experiment Station building, and the amount of rain by means of a gauge, signal service pattern, located in the same plat as the soil thermometers.

1889.

	Wind.		Rain.
	Mean distance travelled per day. Miles.	Velocity per hour. Miles.	Amount. Inches.
April,	253.93	10.58	1.36
May,	189.83	7.91	1.61
June,	171.12	7.13	4.86
July,	200.33	8.34	3.27
August,	139.35	5.81	1.69
September,	198.06	8.25	2.10
October,	194.31	8.09	3.96
Mean,	192.42	8.02	Total, 18.85

1890.

	Wind.		Rain.
	Mean distance travelled per day. Miles.	Velocity per hour. Miles.	Amount. Inches.
April,	241.73	10.07	1.98
May,	235.14	9.79	10.13
June,	230.40	9.60	3.78
July,	166.28	6.95	3.84
August,	187.03	7.65	5.39
September,	155.59	6.45	4.21
October,	189.01	7.85	3.19
Mean,	200.74	8.34	Total, 32.52

1891.

	Wind.		Rain.
	Mean distance travelled per day. Miles.	Velocity per hour. Miles.	Amount. Inches.
April,	210.55	8.77	3.13
May,	206.25	8.59	2.76
June,	182.71	7.61	3.13
July,	185.44	7.73	3.36
August,	169.58	7.07	4.38
September,	162.07	6.75	3.50
October,	191.92	8.00	2.81
Mean,	186.93	7.79	23.07

For the full year 1890, the mean daily velocity of wind was 211.16 miles, and the mean hourly velocity, 8.90 miles; and for the full year 1891, the corresponding velocities were respectively 214.82 miles and 8.95 miles. The rain-fall in May, 1890, amounting to 10.13 inches, was larger than in any other month in twenty-three years.

Conclusion.

A summarized report, like that which has been presented, while in proper form for inferring laws and deducing general principles, conveys but little idea of the nature and daily requirements of the meteorological work in progress.

In order that these points may be more definitely apprehended, I append the records for one month of 1891, selecting the month of September.

An examination of the original records discloses much of interest that cannot appear in a condensed summary.

It is by the careful study of observations and records covering a considerable period of time, that general laws pertaining to this subject are discovered, and truths are revealed which are of importance to mankind.

HYGROMETER NO. 1.—IN OPEN FIELD.

SEPTEMBER, 1891.

Day.	7 A. M.				1 P. M.				7 P. M.			
	Dry bulb.	Wet bulb.	Dew point.	Humidity.	Dry bulb.	Wet bulb.	Dew point.	Humidity.	Dry bulb.	Wet bulb.	Dew point.	Humidity.
1....	52.5	50.4	49	87	60.0	57.5	56	86	54.8	54.3	54	97
2....	52.9	52.0	51	94	64.5	59.6	57	75	61.6	60.2	60	92
3....	49.2	49.2	49.2	100	73.6	64.7	60	62	64.8	63.6	63	94
4....	63.7	62.3	62	92	72.0	61.2	54	54	66.0	63.0	61	85
5....	49.3	47.5	45	87	67.0	57.2	50	54	59.7	56.5	55	82
6....	54.0	53.0	52	94	60.2	60.2	60.2	100	60.0	60.0	60	100
7....	60.0	60.0	60	100	60.4	60.4	60.4	100	60.7	60.7	60.7	100
8....	54.3	52.3	50	88	65.0	57.1	51	61	57.0	52.0	48	71
9....	46.2	45.0	44	91	65.0	55.7	48	55	60.0	53.5	48	65
10....	51.9	50.8	50	94	68.9	58.4	51	53	58.8	55.3	53	81
11....	54.6	54.0	54	97	72.8	60.3	52	48	64.3	60.1	57	78
12....	49.7	49.7	49.7	100	63.6	56.8	52	66	60.6	59.0	59	92
13....	59.8	59.0	58	95	61.8	57.2	54	76	62 0	60.1	59	89
14....	60.0	60.0	60	100	64.0	62.0	61	90	64.4	57.2	52	64
15....	48.4	47.0	45	89	57.7	51.2	46	64	54.3	50.3	46	76
16....	39.4	39.1	38	98	65.1	56.3	49	57	60.0	55.8	53	77
17....	51.5	50.5	50	94	68.4	58.8	52	56	58.9	56.8	56	89
18....	60.2	59.6	59	97	74.2	70.0	68	82	67.6	67.6	67.6	100
19....	55.8	52.3	50	80	67.7	61 7	58	71	66.0	61.0	58	75
20....	55.0	53.0	52	88	70.3	65.9	63	79	58.0	55.8	55	88
21....	57.8	57.0	56	95	74.3	69.2	67	78	63.1	61.1	60	89
22....	57 0	56.3	56	96	72.7	66.8	64	73	62.0	61.0	60	95
23....	56.0	56.0	56	100	71.8	61.2	55	55	59.8	57.9	57	89
24....	50.0	47.3	45	82	62.8	58.0	55	75	61.0	59.0	58	89
25....	58.5	58.5	58 5	100	64.8	72.0	66	54	73.0	68.0	66	78
26....	60.3	55.2	51	73	69.3	56.7	47	45	65.0	57.2	51	62
27....	51.7	51.0	51	96	72.8	62.1	56	54	58.5	54.0	51	75
28....	55.0	55 0	55	100	76.0	69.2	66	71	62.0	60.5	60	92
29....	62.0	61 0	60	95	73.0	67 0	64	73	65.1	63.0	62	90
30....	53.0	45.2	36	53	59.0	48.2	37	44	51.5	47.2	43	73
Means.....				.92				.67				.84
Mean for month.....												0.81

HYGROMETER NO. 2.—IN OPEN FIELD.

SEPTEMBER, 1891.

Day.	7 A. M.				1 P. M.				7 P. M.			
	Dry bulb.	Wet bulb.	Dew point.	Humidity.	Dry bulb.	Wet bulb.	Dew point.	Humidity.	Dry bulb.	Wet bulb.	Dew point.	Humidity.
1....	54.5	52.7	52	89	63.1	59.6	57	82	55.9	55.2	55	96
2....	53.6	52.8	52	95	65 9	60.0	56	71	62.7	61.0	61	91
3....	52.7	52.7	52.7	100	74.2	65.1	60	62	65.3	63.9	63	92
4....	65.0	63.2	62	91	75.5	69.0	66	72	67.0	64.0	62	85
5....	53.6	52.0	51	91	69.8	59.8	53	55	59.8	56.2	54	81
6....	54.7	53.5	53	93	61.3	61.3	61.3	100	60.7	60.7	60.7	100
7....	60.6	60.6	60.6	100	60.8	60.8	60.8	100	60.8	60.8	60.8	100
8....	57.8	55.0	53	84	66.0	57.3	51	58	57.0	52.2	48	72
9....	48.6	46.7	45	86	66.8	56.3	48	51	60.0	53.2	47	64
10....	55.4	54.2	53	93	70.0	59.7	52	54	61.7	57.7	55	79
11....	57.2	56.3	55	94	73.6	61.7	54	50	66.3	62.0	59	79
12....	53.0	52.3	52	96	65.4	56.9	50	59	62.3	60.6	60	91
13....	60.2	59.0	58	93	63.7	58.6	56	74	62.5	61.0	61	92
14....	60.5	60.5	60.5	100	65 6	63.4	63	89	61.8	58.6	57	83
15....	49.8	48.5	47	91	59.7	54.0	50	69	55.8	52.6	51	81
16....	44.9	44.9	44.9	100	67.9	59.4	51	60	61.2	57.1	54	78
17....	57.0	55.3	55	90	73.2	68.4	66	79	60.2	58.2	57	89
18....	61.2	60.8	60	97	76.5	73.2	72	86	68.2	68.2	68.2	100
19....	55.8	52.8	51	82	68.4	61.2	57	66	64.2	59.0	56	73
20....	60 3	57.2	55	84	74 3	63.8	57	56	58.7	57.0	57	91
21....	60.0	59.0	58	94	75 4	71.0	68	80	63.7	62.0	52	91
22....	57.8	57.0	56	95	74.0	68.8	67	77	62.8	61.2	61	92
23....	56.7	56.7	56.7	100	72.6	61.9	56	54	57.2	56.0	55	93
24....	50.0	47.0	44	80	65.2	60.0	57	74	61.8	59.5	58	88
25....	59.0	59.0	59	100	85 0	72 3	66	54	73.5	68.0	66	76
26....	60.3	55.9	52	75	69 9	57.2	48	45	63.7	56.0	51	61
27....	52.8	51.3	50	91	75 3	64.7	58	56	61.2	56.8	53	76
28....	55.0	55.0	55	100	78.6	70.8	67	69	61.7	60.4	60	93
29....	62.1	61.6	61	97	75.0	68.3	65	71	65.6	63.7	63	90
30....	53.7	46.4	39	57	59.0	49 9	39	47	50.8	46.3	42	71
Means.....				.91				.67				.85
Mean for month.....												0.81

HYGROMETER NO. 3—IN FOREST.

SEPTEMBER, 1891.

Day.	7 A.M.				1 P.M.				7 P.M.			
	Dry bulb.	Wet bulb.	Dew point.	Humidity.	Dry bulb.	Wet bulb.	Dew point.	Humidity.	Dry bulb.	Wet bulb.	Dew point.	Humidity.
1....	46.9	45.4	44	89	57.5	55.0	54	86	52.8	52.8	52.8	100
2....	50.3	49.8	49	97	62.3	59.1	57	83	59.7	59.0	59	96
3....	48.7	48.7	48.7	100	70.0	64.6	61	74	62.9	61.7	61	94
4....	62.6	42.0	62	97	70.2	68.2	67	90	65.2	64.5	64	96
5....	50.0	49.0	48	93	61.2	68.6	57	87	60.4	59.2	58	93
6....	54.0	53.7	53	98	58.7	58.7	58.7	100	59.3	59.3	59.3	100
7....	59.5	59.5	59.5	100	59.7	59.7	59.7	100	59.8	59.8	59.8	100
8....	52.8	52.2	52	96	62.0	59.1	57	84	57.9	56.4	56	91
9....	43 3	42.8	42	96	61.7	57.8	55	79	59.1	56.3	54	84
10....	48.3	48.0	47	98	64.0	59.8	57	78	59.8	58.3	58	92
11....	49.6	49.3	49	99	66.7	61.2	58	73	64.0	61.8	61	89
12....	49.9	49.0	48	93	59.6	54.2	50	70	57.8	57.0	56	95
13....	57.6	57.2	57	97	58.6	55.2	53	81	62.3	61.5	60	96
14....	60.3	60.0	59	98	61.8	61.8	61.8	100	59.0	58.2	57	95
15....	48.1	47.8	47	98	56.8	51.9	48	71	55.5	53.3	53	87
16....	41.5	41.3	41	98	58.6	54.0	51	75	57.0	55.4	55	91
17....	49.3	48.3	42	92	62.8	59.2	57	82	60.2	58.2	57	89
18....	59.0	58.2	57	95	71.8	69.2	69	88	65.4	65.4	66.4	100
19....	55.2	53.0	52	87	63.2	55.3	49	60	61.0	57.4	55	81
20....	48.9	48.3	48	96	64.0	59.0	56	74	59.5	59.0	59	97
21....	56.0	55.0	54	94	67.9	65.1	63	86	63.0	62.3	62	96
22....	56.8	56.0	55	95	64.9	62.7	62	89	63.0	61.2	60	90
23....	55.8	55.8	55.8	100	67.8	63.3	61	78	59.3	57.0	55	87
24....	49.3	48.1	47	92	60.0	58.0	57	89	58.3	57.0	56	92
25....	47.7	47.7	47.7	100	79.2	72.2	69	71	74.5	71.0	70	84
26....	60.4	57.0	54	81	65.8	58.2	53	63	62.9	58.8	56	79
27....	50.6	50.3	50	98	67.9	62.1	58	72	57.8	55.6	55	88
28....	54.4	54.4	54.4	100	70.8	68.0	67	87	61.5	60.0	60	92
29....	61.3	60.6	60	96	71.1	68.0	67	86	65.4	63.8	63	92
30....	51.6	50.0	49	90	58.0	51.0	45	61	52 0	49.0	46	81
Means.....				.95				.81				.92
Mean for month.....												0.89

HYGROMETER NO. 4—IN FOREST.

SEPTEMBER, 1891.

Day.	7 A.M.				1 P.M.				7 P.M.			
	Dry bulb.	Wet bulb.	Dew point.	Humidity.	Dry bulb.	Wet bulb.	Dew point.	Humidity.	Dry bulb.	Wet bulb.	Dew point.	Humidity.
1....	47.0	45.8	45	92	57.7	54.9	53	84	53.5	53.5	53.5	100
2....	50.1	49.4	49	96	62.7	59.2	57	82	60.6	59.8	59	95
3....	47.6	47.6	47.6	100	69.3	64.0	60	75	63.4	62.1	61	93
4....	63.9	62.2	61	96	71.2	67.3	65	81	66.8	64.8	64	95
5....	50.0	48.8	48	92	62.3	57.5	53	75	60.0	59.0	58	94
6....	54.2	53.8	53	97	59.0	59.0	59	100	59.1	59.1	59.1	100
7....	59.8	59.8	59.8	100	59.7	59.7	59.7	100	59.8	59.8	59.8	100
8....	59.1	52.4	52	80	60.2	59.0	58	94	58.3	57.0	56	92
9....	44	43.3	43	95	60.6	56.0	53	76	57.0	55.1	54	88
10....	48.3	48.0	47	98	63.8	59.5	56	78	58.6	56.7	56	89
11....	49.9	49.4	49	97	67.5	61.5	58	71	63.6	61.5	61	90
12....	49.8	49.0	48	94	60.0	54.6	50	70	58.3	57.4	56	94
13....	57.8	57.3	57	97	60.1	55.5	52	75	62.5	61.5	61	95
14....	60.5	60.0	60	97	61.8	61.6	61	99	57.8	57.2	57	97
15....	47.5	47.1	47	96	56.3	53.2	51	82	53.2	51.8	50	91
16....	41.0	40.8	40	99	58.2	53.4	49	73	56.8	55.5	55	92
17....	49.8	48.9	48	93	63.7	59.3	56	77	59.1	57.0	56	89
18....	60.6	59.1	58	94	73.2	70.0	69	85	65.8	65.8	65.8	100
19....	54.2	52.8	51	91	64.2	56.7	51	62	61.3	57.8	55	81
20....	49.8	49.1	49	96	65.8	60.0	56	72	58.8	58.3	58	97
21....	56.2	55.9	55	98	68.8	65.2	63	83	63.2	62.4	61	96
22....	56.5	56.0	56	97	65.6	63.3	62	88	63.8	62.0	61	91
23....	56.4	56.4	56.4	100	68.2	63.9	60	75	57.8	56.6	56	93
24....	50.0	48.9	48	93	62.0	59.0	57	84	59.8	58.3	58	92
25....	48.0	48.0	48	100	79.0	71.4	68	70	72.5	69.0	68	84
26....	60.0	57.0	55	84	66.9	58.0	52	58	62.0	58.2	55	80
27....	54.0	50.6	50	97	70.1	63.1	59	68	58.0	55.9	55	89
28....	54.7	54.7	54.7	100	72.7	69.0	68	83	61.3	59.8	59	92
29....	62.0	61.3	61	96	72.4	68.0	65	79	65.3	64.8	64	97
30....	51.8	50.0	48	88	58.0	50.3	43	58	51.4	49.2	47	86
Means.....				.96				.79				.92
Mean for month.....												0.89

SOIL THERMOMETERS.

1891. September.	1 inch.			3 inches.			6 inches.			9 inches.			12 inches.			24 inches.			36 inches.		
Day.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7P.M.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
1	59.0	61.8	60.8	59.3	62.0	61.5	60.0	60.8	63.0	60.5	61.3	62.0	61.0	61.5	62.0	61.7	61.5	61.3	60.0	6.0	60.0
2	58.5	66.5	63.4	59.0	67.2	64.0	59.5	63.7	62.5	61.5	62.0	63.3	62.0	62.5	62.3	61.2	61.0	61.0	59.8	59.8	59.5
3	57.5	65.9	64.0	58.7	66.7	64.5	59.3	65.4	64.8	61.3	62.5	63.0	61.8	62.5	62.8	60.8	60.7	60.7	59.5	59.4	59.4
4	63.0	67.8	66.8	62.7	67.0	66.3	63.0	64.2	65.3	62.5	63.0	64.8	62.5	62.5	62.8	60.5	60.5	60.5	59.4	59.3	59.3
5	60.3	64.8	64.5	60.5	64.2	64.5	62.6	62.3	63.0	63.3	62.0	62.5	63.0	62.5	62.5	60.7	60.7	60.7	59.1	59.3	59.2
6	61.0	61.5	61.5	61.0	61.5	61.7	62.0	61.7	61.9	62.0	62.0	61.9	62.3	62.2	62.1	60.6	60.6	60.6	59.1	59.2	59.2
7	61.5	61.9	61.7	62.0	62.0	61.5	62.0	61.8	61.5	61.7	61.5	61.3	62.0	61.8	61.7	60.5	60.5	60.5	59.3	59.3	59.3
8	58.8	63.5	62.0	59.0	63.6	62.0	60.5	61.0	62.0	60.7	60.6	61.5	61.5	61.0	61.0	60.5	60.5	60.3	59.3	59.3	59.3
9	55.0	61.3	61.0	55.2	61.3	61.3	58.0	58.5	60.1	59.5	59.0	60.0	60.5	59.8	59.7	60.2	60.2	60.0	59.0	59.1	59.0
10	55.5	62.5	61.7	55.9	62.0	61.9	58.2	59.0	61.0	59.0	58.9	60.2	59.5	59.3	59.6	59.7	59.7	59.6	59.0	59.0	58.9
11	57.0	64.7	63.5	57.0	64.5	64.0	58.7	60.8	62.0	59.4	60.3	61.0	59.7	59.8	60.0	59.5	59.5	59.4	58.8	58.8	58.8
12	58.0	61.5	60.8	58.0	62.0	61.3	59.7	61.8	61.0	60.0	61.2	61.0	60.3	60.8	61.0	59.4	59.5	59.4	58.5	58.7	58.7
13	58.6	62.9	63.0	59.5	61.5	63.0	59.0	60.8	62.5	61.8	61.3	61.5	61.0	61.0	61.0	59.5	59.5	59.5	58.5	58.7	58.5
14	61.5	61.9	63.0	61.5	63.2	62.9	61.5	61.8	62.4	61.2	61.5	61.8	61.0	61.3	61.3	59.5	59.7	59.7	58.5	58.7	58.5
15	58.3	59.5	59.1	57.8	59.3	59.5	59.7	59.2	59.9	60.5	59.7	60.0	61.0	59.4	60.0	59.7	59.7	59.5	58.4	58.5	58.4
16	54.1	59.7	60.5	54.4	59.7	60.7	56.1	58.3	59.8	58.2	57.8	59.0	59.1	58.8	58.7	59.4	59.4	59.2	58.3	58.5	58.3
17	55.7	61.1	61.8	56.0	61.2	62.2	57.9	59.0	61.2	58.5	58.3	59.9	60.0	58.8	59.0	58.9	59.0	58.8	58.3	58.3	58.2
18	59.4	64.8	65.0	59.5	64.3	64.7	59.7	61.2	62.4	59.6	60.0	60.6	59.6	59.7	59.7	58.7	58.9	59.0	58.2	58.2	58.2
19	59.8	61.4	61.8	60.2	61.6	61.9	61.5	60.9	61.7	61.5	60.8	61.0	61.0	60.8	60.7	58.8	59.3	59.2	57.8	58.2	58.1
20	56.0	61.5	60.8	56.0	61.3	61.0	57.7	58.5	60.6	58.7	58.5	59.9	59.8	59.3	59.5	59.1	59.1	59.0	58.1	58.0	58.0
21	58.5	63.7	60.5	58.8	63.5	61.4	59.5	60.8	60.8	59.5	59.6	60.3	59.5	59.7	59.7	58.8	59.0	59.0	58.0	58.0	58.0
22	61.0	64.5	64.0	60.7	64.2	64.0	61.1	62.0	63.0	61.0	61.0	61.8	60.5	60.5	61.0	59.0	59.0	59.0	58.0	58.0	58.0
23	60.5	64.2	62.8	60.5	64.0	62.8	62.5	62.0	62.8	62.0	61.0	61.8	60.7	61.0	61.3	59.1	59.3	59.3	58.0	58.0	58.0
24	57.5	59.5	60.5	57.5	59.3	60.5	59.5	59.2	60.2	60.0	58.5	59.5	60.5	60.0	59.8	59.3	59.3	59.2	58.0	58.0	58.0
25	59.3	63.3	65.8	59.3	64.6	65.8	59.5	61.0	61.3	59.5	60.0	61.5	59.5	59.8	60.5	59.0	59.0	59.0	58.0	58.0	58.0
26	62.1	63.3	63.3	62.3	63.8	63.7	62.5	62.3	63.0	62.0	61.8	62.1	61.4	61.4	61.4	59.0	59.3	59.3	58.0	58.0	58.0
27	57.2	62.3	61.5	57.0	62.5	61.8	59.2	60.0	61.5	60.0	60.0	60.5	60.5	59.3	60.2	59.5	59.5	59.3	58.0	58.0	58.0
28	59.5	63.5	65.5	59.8	63.5	63.7	60.0	60.0	63.0	60.2	59.1	60.5	60.2	59.5	60.3	59.3	59.3	59.2	58.0	58.0	58.0
29	61.5	65.0	64.3	61.5	65.0	64.5	61.5	62.1	63.4	61.0	61.0	62.1	60.5	60.9	61.3	59.0	59.0	59.2	58.0	58.0	58.0
30	59.0	58.5	57.5	59.3	59.0	57.8	61.1	59.5	59.5	61.5	60.2	60.0	61.3	60.7	60.0	59.1	59.3	59.2	58.0	58.0	58.0
Means	58.82	62.88	62.41	59.00	62.85	62.55	60.43	60.99	62.00	60.51	60.48	61.21	60.77	60.60	60.73	59.67	59.70	59.65	58.53	58.61	58.36

SEPTEMBER, 1891.

Day	Maximum and Minimum Thermometers and Record of Sunshine.			Terrestrial Radiation and Sun Thermometer.		Precipitation.			Anemometer observed at 1 P.M.		
	Maximum.	Minimum.	Hours of Sunshine.	Terrestrial Radiation.	Sun Thermometer.	Time of beginning.	Time of ending.	Amount of rain in inches.	Reading.	Number of miles in last twenty-four hours.	Average rate per hour.
	°	°		°	°						
1	61.7	50.3	0	43 6	104.6	1.45 P.M.	Night	.21	847.3	137.1	5.71
2	68.9	50.7	13	41.5	133.8				951.5	104.2	4.34
3	77.0	46.5	13	38.7	135.1				985.8	34.3	1.43
4	71.9	48.8	6	41.3	132.8				342.5	346.7	14.45
5	66.3	48.1	6	42.5	129.2				553.0	210.5	8.77
6	62.5	53.4	0½	48.9	79.1	early a.m			602.4	49.4	2.58
7	62.8	57.8	0	51.2	71.6		8.30 P.M.	2.25	662.4	60.0	2.50
8	67.3	49.9	8	41.8	139.0				881.1	218.7	9.11
9	68.0	39.3	8½	28.8	127.0				42.5	151.4	6.31
10	72.0	43.8	12½	32.3	135.1				173.2	130.7	5.45
11	76.1	43.9	12½	37.3	135.0				277.5	104.3	4.35
12	65.7	45.0	12½	38.8	134.7				335.5	58.0	2.42
13	60.8	43.8	0	39.2	82.3	9.45 P.M.	Night	.10	629.4	293.9	12.25
14	72.3	57.8	6	44.6	119.6	11.15A.M.	1 P.M.	.60	773.2	143.8	5.99
15	62.5	45.9	9	36.5	119.0				957.8	184.6	7.69
16	68.0	38.2	12	31.4	125.1				36.6	68.8	2.87
17	71.9	44.3	12	38.5	122.5				101.3	64.7	2.70
						early a.m	6 A.M.	.05	301.5	200.2	8.34
18	75.4	53.2	3	50.5	118.2	5 P.M.	7 P.M.	.17	625.2	323.7	13.49
19	70.7	54.5	12	50.4	124.9				708.3	83.1	3.46
20	71.0	37.8	12	27.5	123.8				792.6	84.3	3.51
21	74.3	54 0	5	48.0	137.2	2 P.M.	7 P.M.	.10	841.3	48.7	2.29
22	68.8	55.6	0	53.8	110.3				971.5	130.2	5.43
23	73.0	53.5	9	50.5	133.7				145.5	164.0	6.83
24	64.0	44.2	3	36.3	115.3				353.6	208.1	8.67
25	86.0	56 9	12	52.2	133.9				616.0	262.4	10.93
26	73.3	59.9	11	53.9	125.6				723.7	107.7	4.49
27	73.0	40.1	12	34.5	129.8				874.3	150.6	6.28
28	76.2	49.0	9½	39.7	130.0				154.6	270.3	11.26
29	73.9	60.0	3	52.0	130.3	Night	Night	.02	622.4	467.8	19.49
30	60.0	50.7	11½	40.5	111.0						
		Total,	234½				Total,	3.50	Total,	4862.2	
M'ns	69.84	49.23	7.8	42.22	121.65					162.07	6.75

Report of Botanist and Entomologist.

Prof. F. L. Harvey.

The following subjects have claimed attention during the past season:

BOTANY.

1. Germination experiments on the vitality of seeds, continued.
2. *Datura Stramonium*, L. Jamestown Weed. Described.
3. *Raphanus raphanistrum*, L. White Radish, or Jointed Charlock.
4. *Rumex crispus*, L. Yellow Dock.
5. *Rumex obtusifolius*, L. Bitter Dock.
6. *Bromus secalinus*, L. Chess or Cheat, considered and illustrated.
7. Several species of Mosses studied in reference to their value as foods for domestic animals.
8. Continuation of an examination of Potato Rot.
9. Continuation of an examination of Black Knot.
10. Correspondence regarding weeds, seeds and plants.
11. Examination of Seeds for impurities.
12. Collecting of seeds, weeds, forage and other plants for the herbarium, continued.

ENTOMOLOGY.

13. *Ixodes ricinus*, L. Tick.
14. *Smerinthus geminatus*, Say. Sphinx moth.
15. *Treptogon modesta*, Harris. Sphinx moth.
16. *Sphinx gordius*, Cramer. Sphinx moth.
17. *Agrostis saucia*, Hubner. Climbing cut-worm.
18. *Agrostis Ypsilon*, (Rott.) Greasy cut-worm.
19. *Hadena devastatrix*, (Brace.) Glassy cut-worm.
20. *Apatela lepusculini*, Gue. The Cotton Dagger.
21. *Aphonus tridentata*, Say. Three-toothed Aphonus.
22. *Dytiscus verticalis*, Say.
23. Three species of Rove Beetles.
24. *Elaphidion parallelum*, Newm.
25. *Ptinus brunneus*, Duft.
26. *Aphis mali*, Fabr. Apple Aphis.
27. *Cotalpa lanigera*, (Linn.) Gold-smith Beetle.
28. *Tetranychus 4-maculata*, n. sp. Four spotted mite.

Plants Received for Examination—1891.

WEEDS.

No.	Common Name.	Scientific Name.	From whom Received.	Remarks.
1	Jamestown weed.	Datura Stramonium, L.	Several parties.	Weed in gardens.
2	White Radish, or Jointed Charlock.	Raphanus raphanistrum, L.	A. J. Abbott, West Paris, Me.	Pods abundant in Western oats shipped to Maine.
3	Yellow Dock.	Rumex crispus, L.	Various parties.	Weed in waste ground, fields and gardens.
4	Bitter Dock.	Rumex obtusifolius, L.	Various parties.	Weed in waste ground, fields and gardens.
5	Chess, or Cheat.	Bromus secalinus, L.	Mr. F. V. Barker, Athens, Me.	Weed on the farm.

MOSSES.

6	Bog Moss.	Sphagnum cymbifolium, Ehrb.	Henry A. Sprague, Charlotte, Maine.	Sent for determination and for an examination as to nutritive value for feeding domestic animals.
7	Bear's Bed, or Robin's Rye.	Polytrichum Juniperinum, Hedw.		
8	Splendid Hypnum.	Hypnum splendens, Hedw. H. proliferum, L.		
9	Schreber's Hypnum.	Hypnum Schreberi, Willd.		
10	Reindeer moss—a lichen.	Cladonia rangiferina.	Collected at Orono.	Analyzed for comparison.

List of Insects Reported and Examined—1891.

No.	Common Name.	Scientific Name.	By whom Reported.	Remarks.
1	Tick.	Ixodes ricinus, L.	Thos. Lord, Skowhegan, Me.	Infesting domestic cat.
2	Sphinx Moth.	Smerinthus geminatus, Say.	W. N. Bond, Orono, Me.	About apple trees.
3	Sphinx Moth.	Triptogon modesta, Harris.	Q. E. Young, Costigan, Me.	Habit not reported. Food plants, poplar and cottonwood.
4	Sphinx Moth.	Sphinx gordius, Cramer.	L. E. Fogg, S. Thomaston, Me.	Said to be feeding on the foliage of plum trees. Not abundant.
5	Climbing Cut-worm.	Agrostis saucia, (Hubner).	W. K. Burgess, Monroe, Me.	The eggs of this in abundance were found attached to resined cloth used for grafting.
6	Greasy Cut-worm.	Agrostis Ypsilon, (Rott.)	N. H. Sleeper, Lewiston, Me.	Working in corn, potatoes and beans.
7	Glassy Cut-worm.	Hadena devastatrix, (Brace.)	John M. S. Hunter, Farmington, Me. N. H. Sleeper, Lewiston.	Doing great damage in lawn of public building, and to corn.
8	The Cottonwood Dagger.	Apatela lepusculini, Gue.	W. H. Phinney, Standish, Me.	Upon plantain in door yard.
9	Three-toothed Aphonus.	Aphonus tridentatus, Say.	N. H. Sleeper, Lewiston, Me. C. V. Manley, Auburn, Me.	Accused of cutting off corn below ground.
10		Dytiscus verticalis, Say.	F. H. Skinner, Corinth, Me.	Found in cellar among potatoes.
11	Rove Beetles.	Three species.	W. K. Burgess, Monroe, Me.	Abundant fastened to resined cloth used for grafting.
12	The Parallel Elaphidion.	Elaphidion parallelum, Newm.	W. K. Burgess, Monroe, Me.	Boring in plum twigs.
13		Ptinus brunneus, Duft.	Mrs. E. Gardner, Calais, Me.	Live larva and beetles in red pepper.
14	Gold-smith Beetle.	Cotalpa lanigera, Linn.	Allen Reed, Frye, Me.	Habitat not stated.
15	Apple Aphis.	Aphis mali, Fabr.	Ch. H. Pope, Manchester, Me.	Feeding on raspberry bushes.

Remarks.

Those of the above named plants and insects that have been sufficiently studied, or are of enough importance receive consideration below. The plates and cuts to illustrate this Report were obtained from the following sources: From the Dept. of Agric., Washington, D. C., the plate of *Bromus secalinus;* cuts 1, 2, 3, 4, 6, 7 and 10 from J. B. Lippincott & Co., and are after cuts in Saunder's Insects Injurious to Fruits; cuts 5, 8, 11, 12 and 13 were kindly loaned by Prof. S. A. Fobes and are after cuts in the Ill. Repts.; cut 9 is from a drawing made by the writer.

During the past season the writer assumed alone the botanical and entomological work of the Station, but Mr. F. P. Briggs, Assistant in the Natural History Department of the College, has continued in an efficient manner the germination experiments and collecting for the herbarium.

The appointment of a Station Horticulturist has transferred the work of the Botanist and Entomologist largely to the study of life histories of plants and insects found doing injury in the State. The Horticulturist has assumed the work of testing fungicides and insecticides. Insects and plants for identification and questions regarding their habits will be considered by the writer, but questions regarding spraying and spraying apparatus should more properly be referred to Prof. Munson. We take this occasion to say that any one desiring information regarding insects or plants is at liberty to send specimens or ask questions. We are glad to notice an increasing demand for such information. Directions for sending specimens will be found in Experiment Station Report, 1888, p. 194.

The past season has not been characterized by the wide spread occurrence of any one species of fungus or injurious insect. The ravages of the Forest-tent Caterpillar, so serious and threatening in 1890, amounted to almost nothing the past season, as we predicted would be the case in our last Report. The past season was quite wet and many complaints were received of injuries done by various species of cut worms. The Codling Moths and Apple Maggot were as abundant as usual in some sections of the State. There seems to be an awakening to the importance of spraying for Apple Scab and the Codling Moth, as more inquiries have been received than usual regarding fungicides, insecticides and apparatus. Complaints from two sources were received of injuries done to corn by *Aphonus tridentatus*, Say. This insect has never

before been accused of cutting corn in the hill after the manner of a cut worm. Our attention has been directed the past season to a species of mite which is common on house plants in Orono, and also in the forcing house at the College. This is the same species that has done so much damage at Cornell University and elsewhere in green houses. It seems to be wide spread and a serious pest. It is very closely related to the red spider, being a species of *Tetranychus*. There were some newspaper reports of the appearance of the Gypsey Moth in the western part of the State, but we are not able to find any authentic evidence that it is found in the State. The Fall Canker-worm has been gradually increasing in the Penobscot valley for the past four years. Last season it did considerable damage to the foliage of fruit and shade trees in this vicinity, and numerous eggs were laid last fall. It may be expected to give some trouble the coming season. Spraying with Paris green while the worms are young, is the remedy. The Apple Scab seems to be the most injurious fungus the orchardists have to contend with, but the use of copper compounds will no doubt prove an efficient remedy.

It may be well to state that the new Tachinid referred to in the Expt. Station Report, 1890, p. 139, as parasitic upon the Forest-tent Caterpillar and named *Phorocera promiscua*, Townsend, has since been referred by the same author to the genus *Meigenia*, and should now be called *Meigenia promiscua*, Townsend. See Psyche, Nov., 1891, p. 177.

BOTANY.

Jamestown Weed—Thorn Apple.

Datura Stramonium, L.

Specimens of the above species have been handed to us for determination several times during the past five years. We have observed the plant several times as a weed in gardens about Orono, and it may be common throughout the State. Whether introduced in garden or grass seed we do not know. Though it appears from year to year in this region, yet being a tropical plant it would probably not spread. It is a native of *Asia* introduced in America. In the South it grows several feet high and is a rank weed found about barns and out houses where the soil is rich, or in fields and along road sides. The seeds are officinal and constitute the *Stramonium* of the druggist. In the South the seeds are

pulverized and mixed with lard to form an ointment much used for healing sores. The plant may be known by the long, funnel-shaped, white corolla, with a large five to ten toothed plaited border; the large, globular, prickly seed pod, four celled at the bottom; the large, flat seeds, and the ovate, ill-scented foliage. The flowers are borne on short peduncles in the forks of the branching stems. The plant is a member of the order *Solonaceæ* to which the potato, tomato and tobacco belong. It is closely related to *Datura* (Brugmansia) *arborea*, a shrubby plant bearing white *Datura*-like blossoms fully six inches long and grown as a house plant in Maine and called *Wedding Bell*. Those who have access to the U. S. Agr'l Rept. for 1889, will find this plant figured on Pl. VII in the Report of the Botanist.

White Radish or Jointed Charlock.

Raphanus raphanistrum, L.

The following letter from Mr. Abbott, together with the response, being of general interest, are recorded.

West Paris, Me., Jan. 2, 1890.

W. H. Jordan.

Dear Sir:—I send you some oats with which are some seeds that are new to me. Can you tell me what they are? They are Western oats such as are brought here by the car load for feed.

Very Respectfully,

A. J. ABBOTT.

Response.

Orono, Me., Jan. 9, '91.

Mr. A. J. Abbott,

West Paris, Me.

Dear Sir:—Your letter and package were handed me by Prof. Jordan for consideration. The foreign matter in the oats sent consists of the pods and included seeds of *Raphanus Raphanistrum, L.* The Wild Radish or Jointed Charlock. The plant yielding these pods is a troublesome weed in Eastern New England and farther west. It is a near relative of the garden Radish, *Raphinus sativus, L*, and was introduced from Europe. This plant belongs to the Order *Cruciferæ* or *Mustard Family*. The pods are necklace-formed and break into joints by constrictions

between the seeds, as shown by the specimens sent. By examining the joints of the pods, you will find the *brownish spherical* seeds. What the physiological effects of eating so much radish seed would be upon animals I cannot say, but as the seeds of some *cruciferous plants* yield an irritating pungent oil, the effect would probably be like that of mustard seed, laxative and stimulating to the digestive organs. This effect would not be desirable in healthy animals. The radish seed, though an adulteration, would have some nutritive value. Clean oats would be preferable and this adulteration ought to make them of less market value. Such oats should not be used as seed, as this bad weed would be introduced wherever they were sown. It would not be possible to feed such oats on the farm without introducing the weed. We would advise farmers not to buy them. The weed is already in the State, being rather common about Orono. Care should be taken not to further extend it. It may be said in its favor, that it is an annual; and could be eradicated in one season, by careful tillage. We would like to know whether the oats received from the West are often thus adulterated or whether this is the first time you have seen it. I wish you would send me a quart of the seed adulterated just as taken from the car. I want to determine the per cent. of foreign matter and keep the sample for the museum.

Yours very truly,

F. L. Harvey,

Botanist for the Station.

Yellow Dock and Bitter Dock.

Rumex crispus, L, *and Rumex obtusifolius*, L.

The above species sent for determination are common weeds in fields, gardens and waste ground. They are naturalized from Europe. The Curled Dock is smooth, has lanceolate acute leaves with the margins strongly wavy curled. The lowest leaves truncate or scarcely heart-shaped at the base. The flowers in crowded whorls on a long wand-like raceme. The valves (three inner sepals) round, heart shaped with an obscure toothed or entire border and nearly all grain bearing.

The Bitter Dock has a rough stem, the lowest leaves ovate heart-shaped and obtuse. Flowers in loose, distinct whorls. The valves strongly veined, ovate shield-shaped with sharp, awl-shaped teeth at the base. Only one usually grain bearing.

These plants belong to the order *Polygonaceæ* or Buckwheat Family, and are related to the smart weeds and the cultivated buckwheat. They are figured in the U. S. Agr'l Rept., 1889, Pl. VIII and IX in the Rept. of the Botanist.

Those interested in the species of *Rumex* (docks) occurring in the United States, will find all the species considered (about twenty) and finely illustrated in the Third Annual Report of the Mo. Bot. Garden, in an article from the pen of Prof. Wm. Trelease, Director, St. Louis, Mo.



CHESS, OR CHEAT

(Bromus secalinus, L.*)*

Chess, or Cheat.

Bromus secalinus, L.

A letter containing specimens of the above named grass was received from Mr. F. V. Barker, Athens, Me., who stated that the plant grew on his farm and he wished to know whether it was of any value. The following response may be interesting in connection with the cut we give of this species on the opposite page.

Orono, Me., Dec. 10, '91.

Mr. F. V. Barker,

Athens, Me.

Dear Sir:—The specimen of grass you forwarded to Prof. Balentine has been handed to me for examination. It is Chess or Cheat, known to botanists by the name *Bromus secalinus*, L. Some farmers still hold to the old tradition that Chess is a degenerate wheat, but most now know it is a distinct species, which sometimes overruns grain fields. The seed is sometimes sown with the grain, but more often gets in from neglected fence corners or hedge rows. It is a very hardy, coarse plant, that seeds profusely and would soon overrun a field if not checked. It is an annual, hence careful cutting for one season would eradicate it. It is of no value to the farmers of Maine, though it has been suggested as a winter grass for the South, where some of its near relatives are esteemed. It is rather to be regarded as a weed and should be destroyed. It is not a native grass, but was introduced from Europe. It may be recognized by the aid of the accompanying cut and the following description: Flowering glume oblong, convex on the back; flowers lapping over one another before expanding; lower empty glume distinctly 3—5 nerved, the upper 5—9 nerved, annual; panicle spreading, even in fruit, the drooping peduncles little branched; spikelets oblong-ovate, turgid, smooth, of 8—10 flowers; glume rather longer than the palet, short awned or awnless; sheaths nearly glabrous. Growing in fields or waste places as though introduced.

Respectfully,

F. L. Harvey,

Botanist for the Station.

Examination of Mosses.

L. H. Merrill and F. L. Harvey.

The following letter was received at the Experiment Station last fall.

Charlotte, Me., Nov. 30, 1891.

Messrs. of the Experiment Station.

Dear Sirs:—As the U. S. Agr'l. Repts. and Bentley's Botany, state that some mosses are rich in nutriment, and as our school text books skip these cryptogams, I send you three specimens for examination, which I hope you will report upon to me as soon as convenient.

No. 1 is found in large quantities covering mossy low bogs with a soft cushion from six to eighteen inches thick. If *scalded* and mixed with a very little *corn meal* it is eaten with apparent relish by swine.

No. 2 grows on a little higher ground around the edge of bogs.

No. 3 grows in sandy places on high ground. Have any of them any nutritive value as foods for animals?

Yours truly,

HENRY A. SPRAGUE.

The specimens refered to above were submitted to the Botanist of the station for botanical determination and to the Chemist of the station for analysis, with the following results.

Botanist's Report.

No. 1. Sphagnum cymbifolium, Ehrb. Bog Moss.

No. 2. Polytrichum Juniperinum, Willd. Bear's Bed, or Robin's Rye.

No. 3. Hypnum splendens, Hedw.—H. proliferum, L.

No. 4. Hypnum Schreberi, Willd.

No. 5. Cladonia rangiferina. Reindeer Moss—a *lichen*.

Remarks.

Mr. Sprague's No. 3 was a mixture of two species, Nos. 3 and 4 above, which are reported in the analysis. No. 5, the Reindeer Moss, being a well known food of species of *Cervidæ*, was submitted to chemical examination for the sake of comparison.

The accounts given in works on botany, or elsewhere of *mosses*

being used as food for man and the lower animals, generally if if not always refer to *lichens*, which should not be confounded with the *musci* or true mosses. We find no authentic record of *true mosses* being eaten voluntarily or having been fed to domestic animals. It is a fact of common observation that the domestic animals reject them. This may be due to their being unpalatable or possibly in some cases to deleterious properties. As animals will not eat them unprepared, they would have to be mixed, if fed, with something to make them palatable, as was done by Mr. Sprague. Whether they possess deleterious properties would have have to be determined by feeding experiments for each species. As the mosses have apparently never been examined chemically to determine their nutritive value, the results of the Station Chemist given below will be interesting. They indicate that the species examined contain much more nitrogen than the *lichen* (reindeer moss,) which is freely eaten by species of deer and that they compare favorably with timothy hay in amount of nitrogen, though it is less easily digested. A series of experiments to determine palatability, deleterious properties and digestibility would be interesting. A more exhaustive analysis might detect compounds that would materially affect the food value. The following is the

Report of the Chemist—Mr. L. H. Merrill.

Since the mosses are not likely to become very important food plants, it was not thought advisable to make a complete analysis of the specimens submitted, but to confine the work to a brief examination of the nitrogenous compounds which they contain. While we do not know the exact nature of these compounds as they exist in the species examined, yet it may be assumed that their value may be determined with some degree of accuracy by applying the same methods used in the study of fodders.

It is evident that the value of the mosses as food must depend upon their digestibility. They were accordingly submitted for twenty-four hours to the action of pepsin solution, prepared in the ordinary manner. The nitrogen was determined in the undigested residues, and the per cent. of the whole amount of the nitrogen digested calculated from these figures.

As a matter of interest a common lichen (Cladonia rangiferina) was added to the list. Two well-known fodders, Timothy Hay and Alsike Clover, have also been inserted in the table for more ready comparison.

Station number.	Names.	Mixture.	Total nitrogen.	Not digested by pepsin, %	% of total not digested.
CLIII....	Sphagnum cymbifolium, Ehrb.....	8.30	.89	.60	33
CLIV....	Polytrichum juniperinum, Willd...	5.25	.90	.74	18
CLV.....	Hypnum splendens, Hedw.....	10.09	1.24	.79	36
CLVI....	H. schreberi. Willd.....	9.80	.94	.73	22
CLVII...	Cladonia rangiferina.....	6.59	.42	.23	45
XLIV....	Timothy Hay	.....	1.20	.34	72
XLI.....	Alsike Clover.....	.....	2.03	.55	73

It will be seen from these figures that one of the mosses contains as much nitrogen as the Timothy Hay; the others about three-fourths as much. The digestibility, however, in all of them is very low, in none of them reaching more than one-half that shown by Timothy. Nevertheless, if these figures be accepted as representing the actual food-value of the mosses and they prove palatable—which is doubtful—the facts obtained would seem to justify farther study.

Examination of Seed for Impurities.

The Station is prepared, so far as its facilities permit, to examine seeds for the presence of noxious weeds, and report upon them. Below is given the results of an examination to call attention to the nature of the work. Seeds of weeds present that can not be identified at sight, are grown and positively determined from the plant. Those intending to plant large areas of clover or grass could be assured of the absence or presence of noxious weeds and sometimes avoid the introduction of pests hard to eradicate when once established.

Report.

Weight of seed examined, one half ounce.
Name of seed, Red Clover, Trifolium pratense, L.

Total number of weed seeds,	121
Harmless—Herds Grass, Phleum pratense,	30
Harmful—Fox tail, Setaria glauca,	59
" Smart weed, Polygonum acre,	12
" Black Bindweed, Polygonum convolvulus, L,	
" Polygonum ?	
Rib Grass, Plantago lanceolata, L.	5
Unknown Weeds, two kinds,	15
Total,	121

Received from Mr. G. S. Flood, Waterville, Me., and purchased from F. J. Savage, Ft. Fairfield, Me.

Remarks.

It is impossible to get seed entirely free from foreign seeds. It is important, however, whether the few found are *harmless* like herds grass seed in clover, or whether they are the seeds of bad weeds. The above seed can not be regarded dirty, as the weight of foreign matter is very small, but it contains the seed of the *foxtail* and *English plantain*, one would not care to introduce in a meadow. For my own planting I would reject such a seed as the above.

ENTOMOLOGY.

Ticks.

Ixodes ricinus, L.

(Ord. Acarini: Fam. Ixodidæ).

We received specimens of a species of Tick from Mr. Thos. Lord of Skowhegan, found on the domestic cat. The American species of Ticks have not been studied much and the writings on the subject are meagre. Not being able to find a description of the species, some of the specimens were referred to the Dept. of Agric., Division of Entomology. They were examined by Dr. Marx, and Prof. Riley writes us that the form is *Ixodes ricinus*, L. The species sent us is very common in Maine and is the one which so badly infests our wild hare, or rabbit. We have seen rabbits during the month of July with the head almost covered with these ticks and in such a condition it must have been a misery to live.

Dr. Marx of the Dept. of Agric., we understand, is studying this group, and we may hope for a monograph of our American species.

Sphinx or Hawk Moths.

(Order Lepidoptera: Fam. Sphingidæ.

During the past season three species of sphinges have been received for examination, viz: *Smerinthus geminatus*, Say., *Triptogon modesta*, Harris, and *Sphinx gordius*, Cram.

As these moths are apt to attract attention on account of their size, a few words regarding them may be interesting.

They are called Sphinx moths, or Sphinges, because the *larvæ* have the curious habit of raising the anterior portion of the body and remaining motionless for a long time in that position, thus bearing a fancied resemblance to the fabled *Sphinx*.

Habits.

The eggs are laid singly on the food plant, hatch in one or two weeks; the young larvæ are usually pale green or yellowish green and clothed with short, erect hairs. They molt or shed the skin about four times before they are fully grown. They have on the twelfth segment a spine that curves backward and is called the *caudal horn*. (This horn disappears after the first molt in a few species.) The mature larva is cylindrical and smooth or granulate. When done feeding they descend and usually enter the ground to transform, though a few make imperfect cocoons on the surface made of leaves drawn together with silk.

The moths are medium sized to large, the bodies short, fore wings comparatively long and narrow, hind wings much smaller, head large, clothed with hair-like scales, either tufted or appressed; eyes, large, hemispherical, naked. The proboscis usually long and slender and when not in use, coiled like a watch spring between the palpi. The wings usually move rapidly in flight. They are sometimes taken for humming birds. This is quite a large family, there being, according to Prof. J. B. Smith, over eighty species in temperate North America. According to Prof. Fernald there are nearly fifty species in New England, the most of which occur in Maine. Quite a number of the species feed upon the foliage of fruit trees, forest trees and shrubbery of economic importance. Of those mentioned above, *Smerinthus geminatus*, Say., is a general feeder and has been found upon the apple, plum, elm, ash and willow.

Triptogon modesta, Harris, feeds upon the poplar and cotton wood.

Sphinx gordius, Cramer, (Fernald Sphinges of New England, p. 44, Fig. 1, Pl. 1), has been called the Apple Sphinx on account of its common occurrence in orchards, but it feeds upon the ash, also upon the Sweet Gale (Myrica Gale, L. and the Wax Myrtle, Myrica Cerifera, L.) Those who are interested in the above species, or in the Sphinges generally will find the Sphinges of New England considered in detail in Fernald's Sphingidæ of New England, published in the Agr'l Rep't of Maine, 1886, or the Sphinges of America, north of Mexico, in Prof. J. B. Smith's Monograph, published by the American Entomological Society of Philadelphia, Pa.

Cut-Worms.

The following letter regarding cut-worms was received at the Station. We place it and the answer on record as containing information perhaps important to others.

Farmington, Me., 6, 5, 1891.

Dear Sir:

I send you by this mail specimens of a worm which is destroying a lawn in this place, in front of and around our county building. The soil is sandy and it has been top dressed for several seasons to get the lawn; and now the turf is about two inches thick. Rear of the building is a cemetery, been there for over a century.

Will you kindly look into this matter; tell us what the worm is, how to prevent further ravages by it, and what to do to kill out the thousands of worms now eating away at the grass roots.

I shall make an item about this lawn, also say I have sent specimens to the State College; and I hope you will write an article upon them to print in my paper. Nobody here, thus far has ever seen these worms here before.

Yours very truly,

John M. S. Hunter.

Answer to Mr. Hunter's Letter.

Orono, Me., July 24, '91.

Editor of Farmington Chronicle:

The specimens which you sent me some time ago for examination prove to be the Glassy Cut-worm known to entomologists as *Hadena devastatrix*, (Brace). There are a great many species of the so-called *Cut-worms*; some of them climb trees and eat the foliage, while others work about the roots or base of plants. They all do more or less damage and work at night. As a class they are hard to manage. When they are not numerous and affect gardens, digging them out of the hills where their depredations are noticed, or putting bunches of hay or small boards on the ground for them to hide under, and then examining and killing them, have proved good remedies.

When they affect field crops, meadows or lawns the treatment would have to be different and on a more extensive scale. If the lawn has been so far affected that the grass is dead and re-seeding will be necessary, the ground should be plowed next Spring and before the seed is sown a load of fresh cut grass

thoroughly sprinkled with Paris green in water, 1 lb. to 150 gallons of water, should be spread upon the ground and left a few days. The worms will crowd to the surface for food, eat of the poisoned grass and die.

This same treatment has been successfully tried for cut-worms in corn fields or other crops planted in rows, the poisoned grass or clover being scattered in small bunches between the rows. If the lawn has not been destroyed so that re-seeding is necessary, and it is desired to treat it without disturbing the sod, then we would advise the use of Kerosene Emulsion. This has been successfully used for grubs in lawns at the Department of Agriculture, Washington, D. C.

You will find an account of the Experiments in Insect Life, Vol. 1, No. 2, page 48. (This journal is published by the Department of Agriculture and you can no doubt get a copy by addressing the Secretary of Agriculture.) You will find a formula for the preparation of Kerosene Emulsion in Dep't of Agriculture Report, 1884, page 331, and also some other information on the subject that will be instructive. Other articles on the treatment of cut-worms will be found in Insect Life, Vol. 3, No. 5, page 247; U. S. Agricultural Report 1885, page 270; Prof. Fletcher's Report, Central Expt. Farms, Ottawa, Canada, 1889; Canadian Entomologist 1889, Sept. or Oct., also in the writings of Prof. Cook and other entomologists to the Experiment Stations.

As the above cut-worm goes into the chrysalid state in July, its depredations are probably over for this season and it is more than probable, it apparently being confined to the lawn in question, that it will not give so much trouble next season. The chrysalids hatch into moths in the latter part of August or September and they will scatter to lay their eggs. Cut-worms are apt to be badly preyed upon by parasites and thus destroyed. Should they begin work again next Spring I would advise the grass trap or Kerosene Emulsion treatment. Should you need any more detailed information than I have given, write again.

Yours truly,

F. L. Harvey,

Entomologist for the Station.

Remarks.

The above species, *Hadena devastatrix* (Brace), together with the Greasy Cut-worm, *Agrostis Ypsilon* (Rott.), were received from Mr. Sleeper, Auburn, Me., see letter pp. 200, 201, also reared by the writer from worms doing damage to corn and other crops about Orono. A species of Climbing Cut worm, the Variegated Cut-worm, *Agrostis saucia* (Hubner), was sent by Mr. W. K. Burgess, Monroe, Me.

The above species are considered and figured below. The term *Cut-worm* is very loosely used, being often applied to the larva of the *June bug*, which cuts grass roots; to the *wire worms*, the larvæ of the snapping beetles, and even to the *borers* that cut channels in woody plants. The term cut-worm is principally confined by entomologists to larvæ of the Owlet Moths *(Noctuidæ)*, that have the habit of hiding just under the surface of the ground during the day and feeding upon the roots, stem or leaves of plants by night. When the larvæ climb high and feed upon the foliage of tall plants or trees, they are called *Climbing Cut-worms*.

The cut-worms may be known by the following general characters:

The moths known as *Dart Moths* or *Owlet Moths* are deltoid or triangular in shape (see Figs. 4, 6 and 7) when the wings are closed, and usually fly at night, and often enter rooms, being attracted by the light. The worms when full grown measure from one to two inches in length, have sixteen legs (three pairs of true legs and five pairs of prolegs), thick bodies which taper somewhat at the ends; without hairs and greasy looking, brown gray or greenish with indistinct longitudinal or oblique markings; head long, shining red or brown, head and anal segments armed above with a horny plate, darker than the remainder of the body. On each segment are six or eight dark colored humps, each bearing a hair. (See Fig. 6.) When disturbed the worms curl themselves into a ring as shown in Fig. 2. There are between three and four hundred American species related to the cut-worms and many species besides the above are numbered among the pests of the farm, garden and orchard.

The Variegated Cut-worm.

Agrostis saucia (Hubner).

(Ord. Lepidoptera: Fam. Noctuidæ.)

DESCRIPTION.

Eggs—round, flattened, pink, prettily ribbed and ornamented, laid in patches of several hundred on the twigs of the apple, cherry and peach. Mr. Monroe's specimens were found on the *trunks* of *plum* trees. Fig. 1, *a*, represents an egg enlarged, showing the ribbing and ornamentation. Fig. 1, *b*, represents a cluster of the eggs, natural size, attached to a twig.

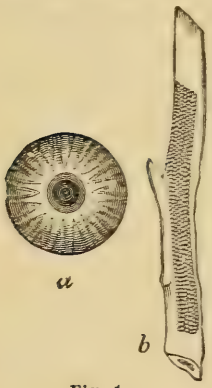


Fig. 1.

Larvæ, when young, dull yellow marked with darker spots. Full grown larva, dull flesh color, mottled with brown and black and elongated velvety black markings on the sides, large, when mature nearly two inches long. Fig. 2 shows the larva at rest and the head magnified to show the markings. The larvæ are mature in June, when they enter the ground form an oval cavity within which they

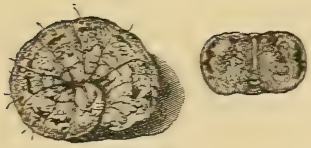

Fig. 2.


Fig. 3.

change to the *chrysalis*, which is deep mahogany brown, pointed at the extremity, as shown in Fig. 3.


Fig. 4.

The *moth*, shown in Fig. 4, expands about one and three-quarters inches and the fore wings are grayish brown marked with brownish black; the hind wings are white and pearly, shaded toward the margin with pale brown. The moth is on the wing in July and lays its eggs as shown above.

The Glassy Cut-worm.

Hadena devastatrix (Brace).

(Ord. Lepidoptera: Fam. Noctuidæ.

The eggs of this species and the egg-laying habit, so far as we know, are not known. Probably the eggs are laid on plants near the ground, which is the usual place of depositing them by cut-worms, and not in the ground, as formerly supposed. Brace, who originally described the moth, says the eggs are laid in autumn and hatch in May. The belief among entomologists now is that most cut-worms hatch in the fall and enter the ground, maturing the following spring.

Larva—length 1.8 inches, color translucent glassy green with a tinge of blue; head venetian-red, jaws black, a small black spot on each side, head shield distinct, hard, polished, dark brown; caudal plate not so well defined and pale. The larvæ is full grown the last of June and soon changes to the *chrysalis*, which is dark mahogany brown, attenuated at the end more than usual, two distinct slightly curved horns at the end with several stiff bristles around them. The larvæ is shown, Fig. 5, natural size; below the larva is one of the segments enlarged, showing the dots bearing hairs, usually found on cut-worms.

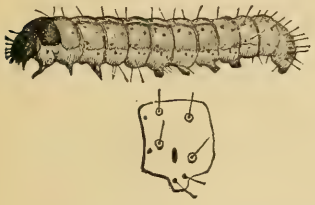


Fig. 5.



Fig. 6.

Moth—spread of wings from an inch and a half to an inch and three-fourths; fore wings grayish brown crossed with four more or less distinct white wavy lines, edged more or less with black; hind wings pale brownish gray. This species is on the wing in July. Those we transformed came out the third week in July. It is shown natural size in Fig. 6.

Feeding upon grass roots and corn in the hill, in Maine. Stalks of corn eight inches high were found cut by this species. Brace says it prefers beans, and several writers accuse it of cutting cabbage. It does not seem to be so abundant in Maine as the next species, though locally about Farmington, Auburn and Lewiston it did considerable damage the past season. This species is found in Canada and in the Southern and Middle States and we believe it has been found in Europe.

Greasy or Black Cut-worm.

Agrostis Ypsilon (Rott.)

(Ord. Lepidoptera: Fam. Noctuidæ.)

Eggs—pale fulvous; nearly spherical, base somewhat flattened; laid in small patches, often of two or three layers and sparsely covered with long scales from the abdomen of the female moth.

Larvæ when full grown about an inch and a half long, dull lead brown color with five longitudinal paler stripes; under side of body pale greenish yellow.

The *Moth*, Fig. 7, has dark fore wings with a bluish tinge on the front border and with a dark brown lance-shaped mark running from the posterior portion of a kidney-shaped spot in the middle of the wing. Hind wings pearly white and semi-transparent.



Fig. 7.

This species is world-wide in its occurrence and does great damage to garden and field crops. It has been found destroying cabbage, tomatoes, potatoes, tobacco, cotton, corn and beans. In confinement it will feed upon apple and grape leaves. There are two broods and the moths are on the wing from April to October. Those we reared emerged the last of August. It was found by Mr. Sleeper cutting corn, but more abundantly by him in potatoes. We bred the moths from worms taken in corn hills, but did not notice their work in potatoes near by.

Remedies.

The remedies may be divided into *natural* and *artificial*. Natural remedies are those provided by nature to hold insects in check and prevent their undue increase. Under this head would come *parasites*, like Ichneumons and Tachina flies, that lay their eggs in the worms and destroy them; *predaceous insects*, as various species of beetles, hemiptera, mites and spiders; *birds*, as the robin, catbird, blackbirds and poultry; and *quadrupeds*, as the skunk and probably moles, all of which eat them.

Artificial remedies are those devised by man to protect his crops, or destroy the insects feeding upon them. They may be divided into *preventive* and *destructive*.

Preventive are those that protect the plants from attack, but do

not destroy the insects. *Destructive* are those that attempt to effectually remove the cause of the injury by aiming at the life of the insect.

PREVENTIVE REMEDIES.

a. *Application of chemicals or other substances to the soil*, which do not poison the worms but makes their food unpalatable. They do not seem to relish *salt* like the higher animals, and its use is highly recommended by Lintner and others. A handful is applied on the surface to each hill. Soaking the seed in *Copperas water*, one pound to the bushel of seed, allowing it to remain twelve hours, and then rolling it in plaster, would come under this head. This method is strongly recommended by Lintner. Tobacco has been used successfully to protect cabbage plants. It is put under the surface around the plants.

b. *By protecting the plants so the worms cannot reach them.* Under this head would come wrapping cabbage and other set plants with brown paper, burdock, walnut, or other leaves, or surrounding the base of the plants with tin or paper tubes or frames. Paper frames should be made broader at the top to prevent the worms crawling up the sides and set a little below the surface of the soil at the bottom. Tin tubes are much more durable. They can be made of slips of tin 2 in. by 10, bent in the form of a cylinder, and bent so as to loop at each end. They should be painted inside to prevent burning the plants by the sun. Bands can be made of tin and put around the base of fruit trees to protect them from climbing cut-worms.

Fitch recommended digging a shallow trench with perpendicular sides around the garden. This is based upon the belief that cut-worms travel to the cultivated ground from the adjoining meadows and pastures to feed upon the tender, cultivated plants.

c. *By thick planting* so as to have a good stand left after the worms have been fully fed. As Fitch expresses it, "plant one seed for the blackbird, two for the crow, three for the cut-worm and three to grow."

d. *By dusting the foliage with dry powders* like hellebore, ashes, or air slacked lime, to make it unpalatable to the worms.

DESTRUCTIVE REMEDIES.

a. *Early plowing in the Fall.* This destroys the weeds upon which the young worms feed and they starve. After summer crops are harvested the weeds are usually allowed to grow, giving the worms abundant food.

b. Late Fall plowing. This should be done after the worms have become torpid and have gone into winter quarters, so as to break the walls of the cells in which they hybernate, thus exposing them more fully to the changes of temperature.

c. Early Spring plowing and late seeding is supposed to cut off their food supply and starve them.

d. Late Spring plowing and seeding is supposed to give the worms a chance to mature on weed food and transform before the crop is planted.

e. Frequent cultivation of sod land is supposed to be beneficial. The moths lay their eggs upon plants near the ground. They deposit more eggs upon grass ground than elsewhere and the worms would accumulate in meadows. Turning every two years is advocated by some. Summer fallowing has been advocated in extreme cases.

f. Making deep holes about the hills with a dibble has been tried with good effect. For this purpose a sharpened stick about two inches in diameter is used. It can be thrust very rapidly deep in the soil once or twice near each hill. This makes a smooth, round hole into which the the worms fall and cannot get out, and they perish or eat each other. To make their death certain go over the field again the next day, thrusting the stick in the same holes to crush them.

g. Pouring solutions about the hills poisonous to the worms. Saltpetre has been used for this purpose and is said to destroy the worms and at the same time provide nitrogen food to the plants.

h. Dipping plants to be set in Hellebore Solution has been successfully used with tobacco plants. We have no record of its being tried for cabbage plants. One pound of Hellebore to ten gallons of water was used for tobacco plants.

i. Digging out the worms when the plants are seen to be affected by them. This is somewhat like locking the barn after the horse is stolen, but you have the satisfaction of destroying the perpetrator. Preventive remedies leave the worms to multiply over two hundred fold. Such a remedy as the above strikes a hard blow at the cause. This is a laborious method, but in connection with thick planting so a good stand will be left, it is effectual and largely practised.

j. Spraying the foliage with London purple, Paris green or Hellebore water will kill species that attack the foliage.

k. Shaking the trees or vines early in the morning and destroying the worms that fall has been recommended for climbing cut-worms.

l. Kerosene Emulsion has been successfully tried at the Dept. of Agric., Washington, D. C., for destroying root-eating grubs in grass grounds and would, without doubt, prove as effectual in killing cut-worms under similar circumstances.

For grass grounds we quote from Mr. Cogan's report to Prof. Riley (Insect Life, Vol. 1, No. 2, p. 49), the following: "The places affected were thoroughly drenched with an emulsion of kerosene in the proportion of one to sixteen, and the ground then well watered. I found that where this emulsion was used the grubs immediately ceased their depredations, penetrated further into the ground and not a live one was found to date after careful search, while in other places, where the emulsion was not used, they are still working in a lively manner." For the details of the experiment see periodical quoted above. The above method could be used to destroy the grubs of the May beetle as well as cut-worms.

We copy the formula for preparing kerosene emulsion from U. S. Dept. of Agric. Rept., 1884, p. 331, where further details may be found.

Kerosene, - - - - -	2 gallons,	67 per cent.
Common soap or whale-oil soap, -	1-2 "	37 " "
Water, - - - - - -	1 "	

Heat the solution of soap and add it boiling to the kerosene. Churn the mixture by means of a force pump and spraying nozzle for five or ten minutes. The emulsion, if perfect, forms a cream which thickens on cooling, and should adhere without oiliness to the surface of glass. Dilute the emulsion, before using, with nine parts of water. The quantities used above, when diluted, would make thirty gallons of wash. Prof. Riley urges the importance of proper emulsion, while Prof. Cook uses the following formula: Dissolve 1-4 lb. hard soap in two quarts boiling water, add 1 pint of kerosene and mix thoroughly. This should form a thick, cream-like mass. Before using, dilute with two gallons of water.

m. Killing the worms before the crop to be jeopardized is up, or the plants to be set are put out. There are several ways of accomplishing this end, known under the general names, ball trap system, and poison ball trap system. In all of these methods the

land should be plowed early and the natural food of the worms destroyed. While they are starving, green food, as grass, clover, cabbage leaves, etc., may be put in bunches through the field. The worms collect to eat this food and crawl into the ground near by when done feeding or secrete themselves under the traps, and can readily be dug out or caught and killed. In the poison ball trap system the food is poisoned, thus saving the trouble of digging or searching for the worms.

Prof. Cook poisoned clover and then forked it from a wagon in small bundles, at intervals through the field. Prof. Riley recommends that the food will keep fresh longer if tied in balls or loose masses. Another party put poisoned cabbage and turnip leaves in rows fifteen to twenty feet apart through the field. The food can be poisoned with Paris green or London purple, preferably in suspension in water, though some have mixed it with plaster or flour.

The Cotton-wood Dagger.

Apetala lepusculina, (Gue.)

(Ord. Lepidoptera: Fam. Noctuidæ.)

The larva of the above species was received from Mr. W. F. Phinney, Standish, Me., and said to be feeding upon the leaves of the door-yard plantain. So far as we know, it has never before been reported as feeding upon species of *Plantago*. As the name indicates, it usually feeds upon the cottonwood, *Populus monilifera*.



Fig. 8.

This species may be known by the following description:

Larvæ, when young, almost white with a distinct black dorsal line, short black tufts and sparsely covered with white hairs. When full grown, greenish yellow and thickly covered with long, soft, bright yellow hairs,

which grow immediately from the surface and curl round the sides each way from the middle of the back; head black. There are two little black spots on the top of both the first and second segments, with a pale line between them. The top of segments 4, 6, 7, 8, 11, each bear a straight black brush of hairs. When at rest the larvæ remains curled upon the leaf as shown in Fig. 8. Our specimen agreed exactly with the above description in the number of black brushes, though some specimens have only three tufts, others six, and occasionally there are a few black hairs among the yellow on the body. Our specimens were received about August 1st, which would indicate the second brood, the first brood emerging in June. When grown the larvæ seek a sheltered place, chink in the bark of a tree or cap of fence, and change to a dark, shiny brown chrysalis, encased in a pale yellow cocoon composed of silk and hairs of the caterpillar. The insect passes the winter in the cocoon.

The *moth* has light gray fore wings with a broken black band near the margin and a few black spots in the middle. Hind wings white with black marks in the fringe.

Three-toothed Aphonus.

Aphonus tridentatus, Say.

(Ord. Coleoptera: Fam. Scarabidæ.)

Scarabæus tridentatus, Say, Jour. Acad. Nat. Sciences, Vol. 1, No. 2, June, 1817. Original description Say's Entomology, Vol. 11, p. 134. Proc. Acad. Nat. Sciences, 1856, pp. 21-23.

The technical description of the beetle as given by Say. is as follows:

Body black, punctured, clypeus, scabrous; an obsolete elevated abbreviated line in the middle; an elevated transverse tridentate line on the anterior submargin, confluent each side, with the lateral reflected edge; tip much narrowed, emarginate, reflected; thorax, punctures generally diffused; scutel impunctured; elytra with punctured striæ, beneath reddish brown. Length three-fifths of an inch. Described from a single specimen brought from Arkansas by Thos. Nuttall.



Fig. 9.

Popular Description of the beetle. Body black, thick set and about three-fifths of an inch long, head and thorax marked with small round pits. The head apparently ending in an upturned border bearing three teeth (the teeth are borne on the clypeus). The wing cases (elytra) each marked with about nine longitudinal pitted furrows, those on the edge obscure; legs stout, under side of body and legs reddish brown. The beetle is shown in Fig. 9, about one-fourth too large. The head is shown turned down so that the suture between the clypeus and epicranium does not show, and the teeth and the clypeus projecting forward appear in relief.

This species is distributed from Maine to Texas, but nothing is known of its habits or transformations. It has not before, so far as we can learn, been accused of doing injury to crops. The writer received specimens of this beetle the past season from Mr. Nathaniel H. Sleeper, Lewiston, Me., and from Mr. C. V. Manley, Auburn, Me. It was accused by both parties of cutting corn in the hill after the manner of the cut-worm. In the mouth of two witnesses the guilt would seem to be established.

Below we give the evidence found in the letters accompanying the specimens.

LEWISTON, ME., June 25, 1891.

To W. H. JORDAN, M. S. C:

Dear Sir:—I herewith send to you some samples of a corn destroyer that I found while hoeing my corn. What I want to know is whether the bugs I send are enemies or friends; whether the bug eats the corn, or whether he is after something that does. I found some ten or twelve of these bugs just by the stalks of corn and sometimes one or two inches under the surface, and sometimes there were two or three stalks eaten in one hill. In three instances I found the black cut or corn worm; once the worm and bug in the same hill, and one time a worm in the midst of the stalk eating his way up.

If you can put me in the way of saving the corn you will oblige me very much.

NATHANIEL H. SLEEPER.

When we received the above letter we were of the opinion that the cut-worms were entirely responsible and we wrote Mr. Sleeper to this effect and requested him to examine farther, and following is the response.

2ND LETTER.

LEWISTON, Me., July 1st, 1891.

F. L. HARVEY:

Dear Sir:—I received your letter last evening and thank you very much for it. I went out early this morning and dug into some hills of corn. In the first one found a beetle. Dug into a few more and found none, but found 24 hills of corn that had been dug into during the night. In some of them the roots had been all laid bare, and some only dug into at the side by some animal, I think a *skunk*. I suppose he was digging for beetles.

This evening I went out to the corn to look for worms and beetles. I dug into twenty hills; in nine of them I found the same beetle, in five were worms, in six were nothing found; in two of the five were worms in the stalk above the ground about 3 inches. The smallest one I send to you.

The large, dark colored one is he that eats off the stalk above ground and eats potato stalks and the beans more than he does the corn. The other two large ones were found where the stalk was eaten an inch below the surface, one in a place. These two are larger than others, and had the same appearance of those I found some days ago.

The largest black worm is seldom found in my corn; he is plenty in the potatoes. The two large, light colored ones I have found more plenty in the corn.

I send you a little box with some specimens.

Yours truly,

N. H. SLEEPER.

LISBON, ME., June 9th, 1892.

TO F. L. HARVEY, ESQ.:

Dear Sir:—I received your letter a short time ago and was immediately called away, hence the delay, and will say that the ground was new land, was in grass for ten years, was never plowed before.

In the fall of 1890, I took out the stumps and stone—large pine stumps and lots of them. In many places the old forest mould was plenty. I think the beetle was a native of such places.

The manure was barnyard scrapings with Clark & Williams' superphosphate. I found no corn cut so low down where the cut-worm was. I found some cut-worms but not many; those that were cut (as I think) by the beetle were cut snug to the kernel or

to the roots of the corn. You remember I wrote you the second letter; in that told you of twenty hills injured. If I remember, was six beetles found; some of them in close to the injured corn, though not quite certain of it. I feel certain he is the fellow that did it. N. H. Sleeper.

From the above evidence it seems certain that the beetles are in part responsible for the injury. This opinion is strengthened by the letters from another locality given below.

Auburn, Me., June 27, 1891.

Prof. F. L. Harvey:

Dear Sir:—I send you by this mail two beetles that we found eating the corn stocks, cutting them off just below the ground in the same manner as the cut-worm. C. V. Manley.

Auburn, Me., May 1892.

Prof. F. L. Harvey,

Orono, Me.:

Dear Sir:—Your letter of the 23d received. The beetles that I sent you last season were found where barn manure was spread on the land and phosphate put in the hill. There were but very few cut-worms on the piece and not any in the hills where we found the beetles.

C. V. Manley.

As this beetle belongs to the same family as the May beetle and others that are found in the larval form in manure, probably it was introduced from that source. As its larvæ is not known nor any of its habits or transformations, nothing can be asserted regarding it. Efforts will be made to procure the larvæ and determine its changes. We know of no remedy better than killing the beetles when found.

Predaceous Water Beetle.

Dytiscus verticalis, Say.

(Ord. Coleoptera: Fam. Dytiscidæ.)

The above species was unusually abundant the last season. Specimens were received from various places and several were found in the writer's yard in Orono, and several specimens caught

by the cats, were taken from them. These insects are water-loving species and are attracted by moisture. Specimens sent by one party were found in the cellar among potatoes. The writer was much troubled by them in his cistern. The water got low and the cistern was filled from the river. The water was not strained and the larvæ probably introduced that way. In a few days the water began to smell and became very offensive. Several of the beetles were taken at various times from the valves of the pump. When water from streams is put in cisterns it should be filtered, and it would be well to keep cisterns closed during the time these beetles are on the wing.

The name *Dytiscus* means a diver and is given on account of the aquatic habits of the larvæ of these insects. The beetles may be known by their oval flattened form, brownish black color with a dull glaucous or sea green tint. The first and second pairs of legs are close together, the hind distant, set far back and used for swimming. The species in question is over an inch and a half long, black above with greenish reflections; thorax margined with yellow; elytra (wing covers) bordered with yellow excepting in front and near the hind margin bearing an oblique narrow yellow band.

The beetles, though larger, are related to the gyrating beetles often seen in large flocks playing on the surface of water and called lucky bugs by the boys. The larvæ are aquatic and are the terror of the ponds and streams, likened to sharks among higher animals.

The Parallel Elaphidion.

Elaphidion parallelum, Newm.

(Ord. Coleoptera: Fam. Cerambycidæ.)

This comparatively rare insect was received from Mr. Burgess of Monroe, in the larval form found boring into the twig of a plum tree. Though of rare occurrence it is interesting enough to figure so it may be recognized when seen.

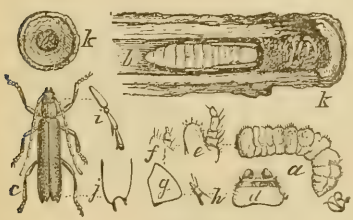


Fig. 10.

Fig. 10 *a* shows the larva, *b* a longitudinal section of the stem exposing the chrysalis in place, *k* a cross section of the chrysalis showing the boring, *d*, *e*, *f*, *g* and

h head and mouth part of the larva, *i* the antenna of the beetle, *j* tip of the wing case. The beetle may be known by its dull brown color. It is a little over a half inch long. The eggs are laid in the axils of leaf buds. The young larvæ bore into the twigs enlarging the channels as they grow and when mature enter the chrysalis state in the stem and in due time emerge as beetles.

The Brown Ptinus.

Ptinus brunneus, Durfs.

Ord. Coleoptera: Fam. Ptinidæ.

The above named family embraces a number of minute species of beetles that do much injury, some boring into fruit trees, others into furniture, while others love animal food and injure hams, museum specimens, leather bound books and clothing.

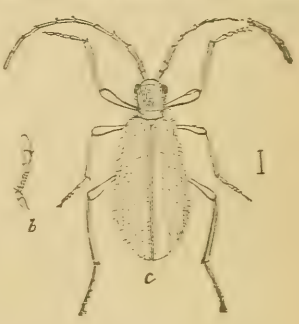


Fig. 11.

The genus *Ptinus* may be known by having the head and thorax much narrower than the wings (elytra); the antennæ about as long as the body, filiform not enlarged or branched. The species *P. brunneus*, Durfs., is only one-eighth of an inch long, dark brown and convex above, thorax narrower behind, densely covered with minute hairs. It is interesting in connection with the correspondence given below. The insect enlarged is shown in Fig. 11, the real size being indicated by the hair line at the right.

Calais, Maine, Jan. 8th, 1891.

To Professor Balentine, Orono:

Dear Sir:—To your address I send by to-day's mail a tin box of red pepper. It has been in our possession since March, 1888. The label, which I did not notice particularly, and unfortunately destroyed when I opened the box, was not removed until recently. The pepper is, as you see, infested with bugs. The box has been subject to all the extremes of our climate, and if the bug would feed upon our vegetation might become a troublesome pest. I hope that I have not foolishly intruded upon your time.

Respectfully,

Mrs. Esther Gardner,
Calais, Maine.

ORONO, ME., Feb. 1, 1891.

MRS. ESTHER GARDNER,
Calais, Me.

Dear Madam:—The box of infested red pepper which you sent to Prof. Balentine proved to be too tearful a subject for his consideration, and was turned over to me. I have wept, sneezed and delayed, but finally have summoned courage sufficient to examine the material and am now able to name the beetles you sent, which possess such strong stomachs and peculiar tastes. I have wondered while I have cried and sneezed, whether they have optic and olfactory nerves as sensitive as mine.

The beetles were probably not in the pepper when you bought it, as they are *Ptinus brunneus*, Durfs., a common, *indigenous* species known to feed upon wood, or sometimes on old books. I believe it has never been reported as feeding on red pepper. It must have found these conditions congenial as there were plump live larvæ of several ages with the beetles in the box. The above species is a brother to Ptinus fur, L., an imported European species that attacks museum specimens and sometimes clothing. The species mentioned with others belong to the Family *Ptinidæ*. Your conscience can be at ease. You have not turned loose in Maine an insect previously unknown to our fauna, for *Ptinus brunneus* is an *American*, besides, he does not aspire to growing vegetation for food but is content with dead vegetable and animal matter.

Yours very tearfully,

F. L. HARVEY.

THE GOLDSMITH BEETLE.

Cotalpa lanigera.

Ord. Coleoptera: Fam. Scarabæidæ.

This beautiful beetle, which is shown about natural size in Fig. 12, may be known by its broad oval shape; lemon yellow color above, head and thorax glistening like burnished gold; the under side of the body coffee-colored and thickly covered with whitish wool; legs brownish yellow or brassy and shaded with green. The larvæ of this insect is a large grub that feeds upon the roots of plants. It has been accused of injuring strawberries. It is shown natural size in Fig. 13. It requires three



Fig. 12.

years to mature and resembles the grub of the May beetle.



Fig. 13.

Having received several letters accompanied by specimens of this insect, we give below one received the past season, with the reply, for the benefit of others who may need similar information.

FRYE, Maine, June 26th, 1891.

STATE COLLEGE,

Orono, Maine:

I send a specimen of Beetle which I have never seen before in this State. Please examine it. It is sent in a tin box package.

Yours truly,

ALLEN REED,
Frye, Maine.

MR. ALLEN REED,

Frye, Maine:

Dear Sir:—The specimen you send is the Goldsmith-beetle, known to entomologists as *Cotalpa lanigera*, L., Family *Scarabæidæ*. This insect, in the perfect or beetle stage, feeds upon the leaves of trees, especially the pear, though other trees, as the elm, hickory, poplar and oak are subject to its attacks. During the middle of the day the beetles hide in the trees on the under side of the leaves, and are on the wing in the evening and morning twilight. The beetles come out of the ground in May and June. When abundant they do considerable damage to the foliage of trees, but they are so scaree in Maine we need not be concerned regarding them. This beautiful beetle always claims attention when found. We have specimens from the Kennebec valley and farther west in the State, but have never found or heard of a specimen being taken in the Penobscot valley or eastern part of the State. Will be pleased to answer any further questions you may ask regarding insects.

Yours truly,

F. L. HARVEY.

REMEDIES FOR BORERS.

Mr. Rutillus Alden called our attention to an orchard in Winthrop, Me., owned by Mr. Dexter Remick, that was coming into bearing and had been kept entirely free from borers by rubbing

the trunk of the tree with the hand, while other orchards in the vicinity were infested. Regarding the matter of importance, we addressed some questions to Mr. Remick and condense the following facts from his reply: "My trees, Baldwins and Benonies, are five years old and just commencing to bear. They are planted on sandy loam and have been well fertilized with manure about the roots and are vigorous. My orchard is younger than my neighbors'. There are orchards within a short distance of mine. My trees have never been scraped but are naturally smooth and I have never applied any washes to protect them from borers.

I rub the trunks well with the hand twice every season, once in June and again in September. I rub as low as possible and to some height on the trunk." We tried to secure some larvæ of borers from the adjoining orchards, so as to learn which species of borer was common in the region, but did not. Under the circumstances we are not able to decide regarding the efficacy of the remedy. We see no reason why rubbing about the crown and lower part of the trunk would not destroy the eggs or newly hatched larvæ of the *Round-headed Borer*, (see Station Rept. 1888, p. 153.) The trunk would have to be free from crevices and the rubbing done at the right time, to prove effectual. We see no special efficacy in the hand, and think a stiff brush would be better. If it is the *Flat-headed Borer* (see Station Rept., 1888, p. 155) that is working in the adjoining orchards and the above species rare, the vigor of the trees would protect them, as this borer usually prefers sickly trees, and as it lays its eggs on the *branches* as well as *anywhere* on the trunk, rubbing the base of the trunk would not protect the tree. We hope to get some of the larvæ this season.

We have noticed somewhere another remedy that seems to be simple and apparently practical for the *Round-headed Borer*, viz: to dig away the dirt an inch or two at the base of the tree, then tie around it a piece of thick paper, allowing it to extend a foot or more up the trunk; then put the dirt back. This arrangement prevents the beetle reaching the crown to lay its eggs. The paper should be left on the tree during the time the beetles are on the wing, that is from June to August. The paper could be poisoned with Paris green. Wrapping in this way is also advised to protect trees from rabbits.

BREEDING STATISTICS.

Dr. F. L. Russell.

The material for these statistics was obtained by sending out blank forms to farmers all over the state. The animals reported on were grades and full bloods of all the more common breeds of cows and also comprise a large proportion of "natives."

It is evident that the value of such statistics as these depends upon the number of animals upon which they are based, and the accuracy of the data. We make this brief report from the material at hand, hoping that it may awaken such an interest in the subject that a larger number than have heretofore done so will fill out and return to me the blanks that will be mailed them each year. This is a matter of general interest to farmers and stock breeders and we would urge upon them the importance of filling out the enclosed blanks as fully as possible. It is desired that the weight of the calves shall be taken within twenty-four hours of birth. Where conveniences are not at hand for doing this, that item may be omitted, as an estimated weight is not sufficiently accurate. We particularly desire that the last item on the blank should be carefully considered. We would decide the period of heat so as to include six or eight hours in the first part, the last six or eight hours in the last part, and the rest we would regard as the middle part of heat.

The reports that have already been received indicate that there may be some relation between the time of service and the sex of the calf. If this should prove to be true, it is a matter of considerable importance and we desire that great care be taken to correctly record the time of service.

The average period of gestation for 257 cows reported was three and one-half hours over forty weeks or 281.72 days. For the bull and heifer calves the average time was practically the same, for the bulls 281.74 days and for the heifers 281.69. The shortest period, 243 days, resulted in a heifer calf. The two longest periods were 303 and 304 days and the calves were both bulls. Of the 257 calves 135 were bulls and 122 heifers.

Of the 113 calves of which the weight at birth was given, the average weight is found to be 73.62 lbs. The average weight of

58 bull calves was 76.80 lbs., and of 55 heifer calves 70.11 lbs. The bull calves averaged 6.69 pounds the heavier. The heaviest and lightest calves were both heifer and weighed 122 and 40 pounds respectively.

Eighty-two cows were reported as having been served during the first part of their heat, and they produced thirty-one (37.8 per cent.) bulls and fifty-one heifers (62.2 per cent.)

Of seventy-six cows served during the last part of their heat, forty-two, or 55.26 per cent. produced bull calves and thirty-four (44.74 per cent.) produced heifers.

Summary.

DURATION OF PERIOD OF GESTATION OF 257 COWS.

Maximum period	304.00 days.
Minimum "	243.00 "
Average when calf was a bull	281.74 "
Average when calf was a heifer	281.69 "
General average	281.72 "

WEIGHTS OF 113 CALVES AT BIRTH.

Maximum weight	122.00 lbs.
Minimum weight	40.00 "
Average weight of bull calves	76 80 "
Average weight of heifer calves	70.11 "
General average	73.62 "

RELATION OF THE TIME OF SERVICE OF 158 COWS TO THE SEX OF THE CALVES.

82 cows served during the first part of heat produced
31 bull calves and 51 heifer calves.

76 cows served during the last part of heat produced
42 bull calves and 34 heifer calves.

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